DOCUMENT RESUME

ED 083 005 SE 016 832

AUTHOR	Leiderman, Gloria F.
TITLE	A Longitudinal Study of Mathematical Achievement in the Primary School Years: Description of Design, Sample, and Factor Analyses of Tests.
INSTITUTION	Stanford Univ., Calif. School Mathematics Study Group.
PUB DATE	71
NOTE	157p.; ELMA Report No. 1
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	*Achievement; Achievement Tests; *Curriculum; *Elementary School Mathematics; Evaluation; Longitudinal Studies; Mathematics Education; Primary Grades; *Research; Social Factors; *Socioeconomic Background; Testing
IDENTIFIERS	Research Reports; School Mathematics Study Group; SMSG

ABSTRACT

This report presents the data and statistical analyses obtained in a four-year study (1966-1970) of elementary mathematics (ELMA) in grades K-3. Oakland Public Schools and the San Francisco Unified School District were the two systems involved in this study. Treatment variables included socio-economic level of the community (low or middle) and curriculum used for teaching mathematics (SMSG or the state adopted SRA text series). Details of the design of the investigation are reported along with descriptions of the sample, the measures used to assess achievement and the factor analyses performed on the data. The content of the two curricula are outlined in the appendices. Further interpretations of the statistics and data obtained are given in "ELMA Reports, No. 2" (SE 016 833). (JP)

SCHOOL MATHEMATICS STUDY GROUP

ELMA REPORTS

No. 1

A Longitudinal Study of Mathematical Achievement in the Primary School Years: Description of Design, Sample, and Factor Analyses of Tests

Gloria F. Leiderman

Financial support for the School Mathematics Study Group has been provided by the National Science Foundation.

Printed in the United States of America

ACKNOWLEDGEMENTS

The research reported in the ELMA report series is the result of a joint endeavor. Those primarily responsible for the planning and execution of the study were E. G. Begle, Gloria F. Leiderman, and Irene Rosenthal-Hill.

An advisory panel met with the research staff at periodic intervals and provided valuable suggestions. The members of this panel were:

E. G. Begle	Stanford University
R. P. Dilworth	California Institute of Technology
Clarence Hardgrove	Northern Illinois University
Shirley Ann Hill	University of Missouri
Max Hosier	State College of Iowa
John Kelley	University of California, Berkeley
J. F. Weaver	University of Wisconsin

Field coordination and technical editing were ably carried out by Terry Chay.

The data processing and calculation of statistical information were under the supervision of Edward J. Cruz and Raymond F. Rees.

Development of test items and pre-testing were the responsibility of Helen L. McCullough.

The administrative personnel of both school systems, including superintendents, department heads, curriculum coordinators, and school principals, were interested and cooperative throughout the course of this study. The teachers accepted, with equanimity and good humor, the movement of children in and out of their classrooms during the testing periods. The children were the sine qua non of this research to whom, lastly, our thanks are gratefully acknowledged.

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

The Elementary Mathematics Study (ELMA) was designed to assess children's learning of mathematical ideas during the beginning school years. Mathematical achievement of a sample of children from two curriculum groups and from two socio-economic groups was measured, at regular intervals, from the time they entered kindergarten in the fall of 1966 through their third grade year. In addition to mathematical achievement, periodic assessments were made of general ability or intelligence, of progress in reading, and of attitudes toward school subjects. A follow-up test in mathematics was administered to this sample at the end of their fourth grade year.(1)

1. Background of Present Study

The two areas of work previously undertaken by the School Mathematics Study Group which led up to this longitudinal research were the Special Curriculum Project(2) and the National Longitudinal Study of Mathematical Abilities.(3)

The latter study, NLSMA, followed the mathematics achievement of a large population of beginning fourth, seventh, and tenth graders over a five-year period "to obtain some quantitative information on the cumulative and comparative effectiveness of mathematics curricula, as well as to identify and measure variables associated with the development of mathematical abilities."(4) Thus, ELMA is an extension downward into the primary school years of systematic, longitudinal study of mathematics achievement.

The critical nature of the early school years for learning becomes more apparent when attention is turned toward children coming from areas variously designated as culturally deprived or disadvantaged. These children enter school with fewer experiences which enable academic success than do children from more

---

(1) The immediately forthcoming ELMA Reports will cover kindergarten through grade three only. Fourth grade data are preserved on tape for future analysis.

(2) Leiderman, Gloria F., Chinn, W. G., & Dunkley, M. E. The Special Curriculum Project: Pilot Program on Mathematics Learning of Culturally Disadvantaged Primary School Children, School Mathematics Study Group, Stanford University, 1966.

(3) Wilson, J. W., Cahen, L. S., & Begle, E. G. NLSMA Reports, No. 1, Part A, X-Population Test Batteries, School Mathematics Study Group, Stanford University, 1968

(4) Ibid., Foreword, p. iv.

advantaged homes. In addition, their early disadvantage appears to increase through the course of their schooling such that the deficit becomes cumulative. It was in this context that the Special Curriculum Project had been undertaken to study the readiness of disadvantaged children for learning, at school entrance, and to assess their progress in mathematics in the beginning school years.

The Elementary Mathematics Study, then, was developed to study children's achievement in the primary grades with special attention both to better understanding of the developmental process of mathematics learning and to ascertain the effects of differential early experiences on that learning.

2. Theoretical Position

Current thinking and research in cognitive development[5] suggest that children move through certain regular and specifiable stages of thinking eventually culminating in abstract or hypothetico-deductive thought. During the course of this development, children first rely on direct perceptual experience and manipulation of concrete objects. From this, progress is to abstraction of properties from perceptual activities and manipulating these abstractions within the context of presently occurring events. At this stage, both visual imagery and words may represent the concrete experiences. Beyond this, there is the process of comprehending regularities, then categorizing those regularities which we refer to as attributes, developing generalizations, and forming concepts.

Whether mathematics is viewed as a special language with its own symbol system or as a body of knowledge with increasingly complex concepts to be mastered, this developmental view of abstract thinking appears applicable. In formulating tests for the early school years, this view of cognitive development was relied upon. The development of NLSMA tests had utilized the concept of cognitive levels rather than a developmental process view. These levels, according to which test scales were classified, were computation, comprehension, application, and analysis, and were based upon a modification of the taxonomy formulated as cognitive educational objectives by Bloom.[6]

---

(5) As examples, see Bruner, J., et al., Studies in Cognitive Growth, New York: Wiley, 1966, and Piaget, J., & Inhelder, Barbel, The Psychology of the Child, New York: Basic Books, 1969.

(6) Bloom, B. S. (Ed.). Taxonomy of Educational Objectives, Handbook I: Cognitive Domain. New York: David McKay Company, Inc., 1956.

Although the process and taxonomy views mean two different conceptual approaches, there is a similarity if one uses as the reference point children's cognitive capabilities. That is, the level of computation may be thought to merge with the stage of thinking which utilizes abstraction of physical properties and manipulation of these abstractions, e.g., size, number, within the context of the child's limitations of having to refer back to actual concrete objects. At this same stage, the child may be able to comprehend the principle that he is using, possibly apply it to other similar problems, and to make certain generalizations. It would not be expected that he could handle the analysis level until he reached the stage of abstract thinking previously described.

The primary emphasis in the ELMA study, then, was on mathematics achievement--a cognitive variable. The sets of variables that were predicted to influence achievement were curriculum, socio-economic level, and teacher training in mathematics. These will be discussed in greater detail in the following chapters as will the research design, methodology, sample, and factor analyses of tests employed.

Chapter 2

DESIGN OF THE STUDY

1. Research Design

The philosophical approach to test development relied on two major components:[7] first, that there are cognitive stages or levels to be assessed in children's learning; and, second, that mathematics achievement is not a univariate outcome but has many component parts.

The areas of measurement can be stated, broadly, as student variables and treatment variables. Student achievement was expected to be affected by experiences both within and outside the school situation. The major out-of-school influence, consisting of many specific components that could not be individually and directly measured in this study, was socio-economic level of the community from which the school population was drawn. The primary in-school influence was that of curriculum used for teaching mathematics.

Measures of student variables were obtained through the ELMA tests, through intelligence tests administered in kindergarten, first and second grades, and through readiness and achievement tests administered by the schools. The pupils' attitudes toward school and toward their own competence in reading and mathematics were measured by scales in second and third grades.

Some of the major questions posed in undertaking this study were:

1) Will the differential level of readiness between socio-economic groups expected at the time of entering kindergarten be maintained so that children from the middle group will maintain superiority by the end of third grade? If yes, on what?

2) What are the effects of differential curricula on progress in various components of mathematics achievement?

3) Can long-term changes in performance be assessed through regular measurement over a four-year period which could not be validly assessed by a brief study?

4) Are children's attitudes toward mathematics affected by different curricula?

5) What are the relationships of attitudes toward school, and toward mathematics in particular, to achievement?

---

[7] For the philosophy underlying test development in NLSMA which contributed, in part, to that of ELMA, see NLSMA Reports, No. 7. Further, two individuals were common to both advisory panels--R. Dilworth and J. F. Weaver.

6) Will the differential curriculum and socio-economic effects be maintained through fourth grade, an important transition point in mathematics learning for many pupils?

7) Will retention of concepts the summer vacation be differentially affected by the curriculum us as well as by the socio-economic level of the community?

2. Student Variables

Achievement

Since the learning of mathematics was the primary concern of the ELMA project, achievement in mathematics was measured systematically at the end of each school year. The design included testing the same skills and concepts at increasing levels of complexity throughout the course of the study. The exception to this plan was at kindergarten since the content taught at this level is based upon those abilities hypothesized as pre-mathematics learning from which later formal mathematics is developed. Therefore, the children were tested at both the beginning and end of the kindergarten year on a wide range of skills and knowledge thought to contribute to mathematics learning.

Table 2.1 presents a comprehensive calendar of tests administered during the four years of the study by the area of competence measured and by city.(8) Unless specified as City 1 or City 2, each test was administered in both centers. A more complete description of the test contents will be found in a later section of this chapter.

It can be seen from this table that a readiness test was given by ELMA at the beginning of the kindergarten year, and the Metropolitan Readiness Tests(9) were given by each school system prior to the beginning of formal instruction in the first grade, although at different times in the two cities.

The tests labeled as "General Ability" include three individual standardized tests of intelligence administered by ELMA. These were the Wechsler

---

(8) To the date of this writing, data analyses have been undertaken only for City 1. The data for City 2, as well as for City 1, have been preserved for possible future analysis.

(9) Hildreth, Gertrude H, Griffiths, Nellie L., & McGauvran, Mary E. Metropolitan Readiness Tests. New York: Harcourt, Brace and World, Inc., 1965. See ELMA Technical Report No. 1, Kindergarten Test Batteries, Description and Statistical Properties of Scales, for a description of the scales used and the scale statistics for the City 1 sample.

TABLE 2.1

Test Data Obtained
by Category and Time of Testing

	Kindergarten			First Grade			Second Grade			Third Grade		
	Fall 1966	Mid-year	Spring 1967	Fall 1967	Mid-year	Spring 1968	Fall 1968	Mid-year	Spring 1969	Fall 1969	Mid-year	Spring 1970
Readiness	ELMA K-01		Metropolitan Readiness A (City 2)	Metropolitan Readiness B (City 1)								
General Ability (Intelligence)		WPPSI			Raven Progressive Matrices (City 1)	Lorge-Thorndike Primary I A (City 2)	Kuhlmann-Anderson B (City 1)	WISC (City 1)				
Achievement			ELMA K-02			Stanford Achievement Test Prim. I W / ELMA 1-02 - 1-05			Stanford Achievement Test Prim. II W / ELMA 2-03 - 2-05			Stanford Achievement Test Prim. II X / ELMA 3-02, 3-04
Attitude									ELMA 2-02			ELMA 3-03, 3-04
Retention				ELMA 1-01 (City 1)			ELMA 2-01 (City 1)			ELMA 3-01 (City 1)		

NOTE: Unless otherwise specified, the test was administered in both City 1 and City 2.

school and Primary Scale of Intelligence (WPPSI)[10] given during the middle of the kindergarten year, the Raven Coloured Progressive Matrices Test[11] administered during the middle of the first grade year, and the Wechsler Intelligence Scale for Children (WISC)[12] administered during mid-year of second grade. In addition, each of the two school systems administered group intelligence tests, City 2 utilizing the Lorge-Thorndike, Primary I,[13] near the end of the first grade year, and City 1 giving the Kuhlmann-Anderson[14] early in the second grade year.

Achievement in components of mathematics learning was tested near the end of each school year by ELMA as can be seen in the row labelled "Achievement" in Table 2.1. The Stanford Achievement Test[15] was administered by the two school systems at the end of grades 1, 2, and 3 as part of a State testing program to evaluate progress in reading.

Attitude was measured by questionnaire items at the end of grades 2 and 3. Retention of material taught during a given school year was measured by retesting a subsample of children in City 1 at the beginning of each school year from first through third grade as can be seen from the last row of Table 2.1.

---

(10) Wechsler, D. Wechsler Preschool and Primary Scale of Intelligence. New York: The Psychological Corporation, 1967. See ELMA Technical Report No. 1 for a description of the scales used and the scale statistics for the City 1 sample.

(11) Raven, J. C. Guide to Using the Coloured Progressive Matrices, Sets A, Ab, B. Beverly Hills, Calif.: Western Psychological Services, 1965. See ELMA Technical Report No. 2, First Grade Test Batteries, Description and Statistical Properties of Scales, for a description of the scales used and the scale statistics for the City 1 sample.

(12) Wechsler, D. Wechsler Intelligence Scale for Children. New York: The Psychological Corp., 1949. See ELMA Technical Report No. 3, Second Grade Test Batteries, Description and Statistical Properties of Scales, for a description of the scales used and the scale statistics for the City 1 sample.

(13) Lorge, I., Thorndike, R. L., & Hagen, E. The Lorge-Thorndike Intelligence Tests. Boston: Houghton Mifflin Company, 1964.

(14) Anderson, Rose G. Kuhlmann-Anderson Test, 7th Ed., Booklet B. Princeton, N. J.: Personnel Press, Inc., 1963. See ELMA Technical Report No. 2 for a description of the scales used and the scale statistics for the City 1 sample.

(15) Kelley, T. L., Madden, R., Gardner, E. F., & Rudman, H. C. Stanford Achievement Test. New York: Harcourt, Brace & World, Inc., 1964. Primary I Battery, Form W, was used at first grade; Primary II, Form W, at second grade; and Primary II, Form X, at third grade. See ELMA Technical Report Nos. 2, 3, and 4 for descriptions of the above scales by year and scale statistics for the City 1 sample.

The following sections in this chapter will deal with student and treatment variables. Within the student variable section, achievement will be discussed first, by year, general abilities or intelligence measures will then be covered, and attitude and retention will be dealt with last. The treatment variables section will include descriptions of teacher training and curricula used.

Administration of Achievement Tests

Tester selection and training. Since the achievement tests were developed to minimize the advantages the middle socio-economic group might have over the lower socio-economic group in skills related to test taking, and since the kindergarten and portions of the first grade tests were to be individually administered, the qualifications and training of testers became crucial. Recruitment of testers was done through psychology and elementary education departments of local universities. The individuals selected were primarily graduate students, although in a few instances advanced undergraduates in school psychology, child development, clinical psychology, or elementary education were employed. The one other source of testers was from listings of qualified elementary school teachers who were not, at the time of testing, teaching regularly. Both men and women were hired, and there was no control on sex of tester by sex of child.

Orientation meetings were held prior to each testing period during the first two years of the study (1966-67, 1967-68) to increase reliability of testing across testers. At these meetings the test batteries were discussed, test administration demonstrated, and both questions and practice time allowed. In addition, school regulations regarding the testers' responsibility for the children and their own behavior in the schools were reviewed. Further, procedures for returning the test booklets and materials were covered.

During the last two years of ELMA (1968-69, 1969-70) written communications with testers were adequate to cover the above topics because the majority of testers hired at this time had already worked with the project and were familiar with the testing, schools, and the necessary administrative procedures. In addition, as the children were more able to comprehend printed materials, the tests were given in small groups rather than individually, and the chances for variability in children's performance as a function of the tester's familiarity with the test content and procedure were decreased.

Time of testing. Achievement testing was undertaken at the end of each school year. The testing was generally started at mid-May and was completed by the end of May.

For those students included within the retention sample,[16] testing was done during the second and third weeks of schoo[illegible] September. The testing could not be done during the first week after s[illegible] opened because class assignments were still in flux, and both teachers and principals were unwilling to have testers in the schools until after the initial adaptation and class assignments were more stable.

<u>ELMA Kindergarten Year Tests</u>

The beginning-of-kindergarten battery[17] was conceived as a readiness battery to evaluate each child upon his entrance to formal schooling, and particularly upon those developmental processes and knowledge predicted to facilitate mathematics learning. Both the beginning (K-01) and end-of-kindergarten (K-02) tests were individually administered and required minimal verbal ability, either in comprehension of instructions or in production of responses.

Several of the tasks within these batteries were considered indices of cognitive processes. For K-01, these were color-matching, naming, and identifying; classifying; ordering; geometric shapes-matching, naming and identifying; vocabulary; and visual memory. For K-02 the color tasks were deleted and conservation added to the battery. The remainder of the tasks were included, but simpler items were deleted and more difficult items added.

The tasks within K-01 and K-02 considered to be more direct measures of early mathematics achievement were counting objects, counting members of a given set, formation of equivalent sets, numeral identification and writing, and ordinal number.

Along with performance on the specific scales of K-01 and K-02, ratings on two four-point scales of each child's behavior during the testing were made by the tester. The behaviors rated were "Attention to Tasks" and "Response to Verbal Directions," the former measuring attentiveness and the latter, compliance.

In addition to tests developed by ELMA to measure achievement in mathematics across the primary school years, certain of the tests administered by the two school districts were considered useful for our research purposes. One of these was the Metropolitan Readiness Tests administered in May, 1967, in City 2, and October, 1967, the beginning of the first grade year, in City 1. The MRT was designed to measure children's development in certain skills and

---

(16) The retention study will be discussed in a later section.

(17) A more detailed description of each of the scales within this battery is given in Chapter 4, Factor Analysis of Kindergarten Tests. Statistics for the scales developed from this battery can be found in <u>ELMA Technical Report No. 1</u>.

abilities contributing to readiness for first grade. Five of the six tests within the MRT measure skills and abilities related to reading. A 26-item numbers test taps a wide variety of knowledge relevant to early mathematics, including counting, knowledge of money, recognition of numerals, size concepts, and telling time. The numbers test is discussed in more detail here than the other subtests because it was a very strong predictor of achievement in mathematics at the end of first grade[18] and also appeared prominently in the kindergarten year factor analytic studies to be discussed in Chapter 4.

ELMA First Through Third Grade Tests

The ELMA tests developed for grades one through three are discussed together because the same eight areas of mathematics knowledge were measured at the end of each of these grades.

Small portions of the test batteries for first and second grades were articulated with the end-of-kindergarten tests. Counting objects, counting members of a given set, ordering by size, and conservation[19] were measured at both kindergarten and first grade through individual testing. These tests were, however, given to only a part of the sample since the full battery was too long to be given in its entirety. Certain scales were assigned to one of four test forms for the kindergarten and the first grade tests.[20] For those scales, such as counting objects, etc., listed previously, data are available for only one-fourth of the sample since they were included in only one of the four alternate forms. Some scales were common to all four forms of each test battery, and therefore, were administered to the entire sample.

The kindergarten scales adapted for inclusion in the second grade battery[21] were vocabulary, counting, and ordering pictured sets. These scales, although administered individually in kindergarten, were modified for small group administration at second grade.

---

[18] The data analyses upon which this statement is based can be found in ELMA Report No. 2, A Longitudinal Study of Mathematical Achievement in the Primary School Years: Curriculum and Socio-economic Comparisons and Predictions from Previous Achievement. Stanford University, 1971.

[19] Since data on these scales are available for approximately one-fourth of the sample, and since there was a ceiling effect on them, the scores are not included in the first grade factor analyses reported in Chapter 5.

[20] See ELMA Technical Report No. 1 for a description of the four forms of the kindergarten battery and ELMA Technical Report No. 2 for the first grade battery.

[21] See ELMA Technical Report No. 3 for the second grade battery.

Tests for eight areas of mathematics knowledge and understanding[22] were constructed for administration at the end of first grade and then modified through the following two years. The areas tested were place value; number comparison - order; number line; application - word problems; computation - addition, subtraction, and multiplication; rational numbers; comprehension of the basic structure of arithmetic; and geometry. In the first six of the areas listed, the tests were similar from grade to grade, the only differences being deletion of items that were too simple and inclusion of more difficult items. In the last two areas, comprehension and geometry, the types of items used differed from year to year.

As with the kindergarten year, testers made ratings of attentiveness and compliance on the individually administered portions of the first grade ELMA tests.

The Stanford Achievement Tests provided an index of reading achievement. The two subtests utilized by the schools at each grade from first through third were Word Reading and Paragraph Meaning. A total reading score[23] can be obtained by summing the scores on the two subtests. The Word Reading subtest, according to the test's authors, measures the ability of pupils to analyze a word without contextual cues. The Paragraph Meaning subtest measures comprehension from simple recognition to drawing inferences and utilizing reading for reasoning.

<u>General Ability Tests</u>

The Wechsler Preschool and Primary Scale of Intelligence (WPPSI) was selected after consideration of several standardized tests for measuring general ability at the kindergarten level. The WPPSI was selected in preference to the Stanford Binet because it included a greater number of performance subtests as contrasted with the Stanford Binet which contains more verbal items. It was expected that the performance tests of the WPPSI might be more highly related to certain areas of mathematical achievement than tests more dependent upon verbal ability.

---

(22) The constructive suggestions of the ELMA Advisory Panel in defining these areas and the work of Helen McCullough in developing test items were particularly helpful.

(23) Although the two cities administered the same subtests, different scores were obtained and recorded. Therefore, directly comparable data on this test for the two cities are not available. See <u>ELMA Technical Reports Nos. 2, 3,</u> and <u>4</u> for scale statistics, first through third grades, respectively, on City 1 subjects.

The WPPSI consists of eleven subtests each of which is considered to measure a different ability and, when combined, provide a measure of intellectual capability. Of these subtests, six are verbal and five performance; however, only five of the six verbal subtests are used in determining the verbal score. The full-scale IQ is obtained by combining the verbal and performance scores.

Since it was not financially feasible to test every child on the full-scale WPPSI, a sample of 30% of the ELMA population was given the full-scale test.[24] This 30% sample was selected from those schools in the two cities that had lower mobility rates according to the responses of the school principals to a questionnaire dealing with pupil turnover in their individual schools. Within the lower mobility schools thus identified, a random sample of pupils was selected for the full-scale test.

The remaining 70% were given a short form consisting of two verbal subtests, Vocabulary and Similarities, and two performance subtests, Block Design and Picture Completion. The choice of these four subtests was based partially on previous research with the Wechsler Intelligence Scale for Children (WISC). Since the WPPSI had just been published in the spring of 1967, no studies had yet been done on short forms of this scale.

Vocabulary (verbal) and Block Design (performance) are two of the eight subtests of the WPPSI modified from subtests of the WISC to include items for younger children. They were selected for inclusion in the short form because of the high reliability of each and because, as part of the WISC, they had been shown to have high loadings on a general intelligence factor.[25] The other two subtests, Similarities (verbal) and Picture Completion (performance) were selected because they seemed to be measuring important parameters of intellectual function different from the aforementioned subtests and because each requires a short administration time.

Table 2.2 presents the correlation coefficients for the individual subtests and for the verbal, performance, and total scaled scores. Table 2.3 shows the means and standard deviations for the sample of pupils from whose scores the correlations were obtained. It can be seen that the total scaled

[24] See ELMA Technical Report No. 1 for scale statistics for the City 1 sample.

[25] U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics. Evaluation of Psychological Measures Used in the Health Examination, Survey of Children Ages 6-11, Series 2, Number 15, 1966.

scores for the long and short forms are very well correlated with $r = .92$. The correlations of the verbal and performance scores between the long and short forms are, respectively, $r = .90$ and $r = .88$.

TABLE 2.2

Product Moment Correlations
between Short and Long Form Scaled Scores
of WPPSI, Cities 1 and 2

N = 471

	Subtests				Long			Short		
	Voc.	Sim.	P.C.	B.D.	Verb.	Perf.	Tot.	Verb.	Perf.	Tot.
M112 Vocab.	1.00	.50	.40	.42	.82	.50	.73	.87	.48	.80
M114 Simil.		1.00	.24	.30	.73	.36	.60	.86	.32	.70
M117 Pict. Compl.			1.00	.45	.47	.70	.64	.37	.85	.70
M120 Block Des.				1.00	.53	.80	.73	.42	.85	.73
M124 Long - Verb.					1.00	.65	.91	.90	.58	.87
M126 Long - Perf.						1.00	.90	.50	.88	.80
M128 Long - Total							1.00	.77	.80	.92
M121 Short - Verb.								1.00	.46	.87
M122 Short - Perf.									1.00	.84
M123 Short - Total										1.00

TABLE 2.3

Means and Standard Deviations
for WPPSI Scaled Scores, Cities 1 and 2

N = 471

	MN	SD
M112 Vocabulary	9.4	3.0
M114 Similarities	9.8	2.9
M117 Picture Completion	9.6	2.8
M120 Block Design	10.3	2.8
M124 Long - Verbal	48.9	11.4
M126 Long - Performance	49.5	10.9
M128 Long - Total	98.4	20.2
M121 Short - Verbal	19.3	5.1
M122 Short - Performance	19.9	4.7
M123 Short - Total	39.1	8.4

The Raven Coloured Progressive Matrices Test was selected for use at first grade as a non-verbal measure of general ability. It was expected that the items of this test would relate to mathematical achievement requiring spatial manipulation and perceiving part-whole relationships. This test requires the ability to perceive relationships of a missing portion of a pattern to the whole.

According to Raven, the sets of patterns are designed to assess mental development of children ages five through eleven, or up to the stage when a person is sufficiently able to reason by analogy to adopt this way of thinking as a consistent method of inference. A minimum amount of verbal instruction is given. Items have been arranged in order of difficulty within each set so that subjects can learn about the nature of the test while doing the items.

The format of this test presents, on a page, a colored pattern with a piece missing. At the bottom of the same page are six possible pieces to fit the blank space within the pattern. The possibility of the format itself increasing the difficulty of this test led to pretesting a formboard version in which the pieces could be manipulated and actually placed in the blank space within the pattern. The pretest results indicated, however, that many children did not physically manipulate the pieces. In addition, this form increased the administration time by a factor of two, and the attendant decreased attention appeared to cancel any gains in performance expected to accrue from this version.

Although a group-administered form has been used with first grade children,[26] these tests were administered individually to all of the children in City 1[27] in order to eliminate any advantage that children better able to comprehend verbal instructions in a group setting would have.

The Wechsler Intelligence Scale for Children was employed as the test of general intelligence in second grade. As with the WPPSI, it consists of both verbal and performance subtests. Although at kindergarten some full-scale tests were administered, no full-scale WISC's were given. The subtests of the short form, given to all the ELMA pupils in City 1, correspond to those included in the short form of the WPPSI, i.e., the verbal subtests used were Vocabulary and Similarities, the performance subtests were Picture Completion and Block Design.

---

(26) Freyburg, P. S. The efficacy of the coloured progressive matrices as a group test with young children. British Journal of Educational Psychology, 1966, 36, 171-177.

(27) See ELMA Technical Report No. 2 for scale statistics.

The Lorge-Thorndike Intelligence Tests[28] were administered by City 2 in the spring of the first grade year. The subtests that comprise the Primary Battery of this group-administered test utilize pictorial items and measure abstract thinking in oral vocabulary, pictorial classification, and pictorial pairing.

The Kuhlmann-Anderson Test was administered by City 1 in early fall of the second grade. As with the Lorge-Thorndike, this test was administered by the classroom teachers in a group situation. This test is considered a measure of academic potential. It consists of eight timed subtests none of which requires any reading by the testee. Three of these subtests deal directly with mathematics, unlike any of the other general ability tests. Because it was administered in the early fall of second grade, the IQ scores obtained from City 1 schools are included in the analyses of first grade rather than second grade results.

Attitude

Achievement in school is dependent upon a number of variables, some of which are inherent within the teaching situation, namely, the curriculum and the teacher, and others of which emanate from the learner himself. The child enters school with certain standards of how he should behave and certain expectations of how the teacher will deal with him,[29] as well as with certain experiences and competencies which may either facilitate or impede learning. As he progresses through school, he will develop attitudes about his own abilities to learn and will formulate more or less positive predispositions toward various school subjects. These predispositions, or attitudes, are likely to affect his motivation and his performance.

Much of the research undertaken on the attitudes of elementary school children toward school has used fifth and sixth grade pupils[30] by which age attitudes toward school and particular school subjects have been developed and can be measured by written questionnaires. In the ELMA study, our position is that attitudes toward school are developing during the primary school years,

---

(28) As noted earlier, these data have been retained on tape, but no analysis has been undertaken of City 2 results.

(29) Hess, R., & Shipman, Virginia C. Early experience and the socialization of cognitive modes in children. Child Development, 1965, 36, 869-886.

(30) There is a body of literature on self-concept in young children; however, it is a broader area of personality than could be tested within this project.

that the curriculum may make a difference in the development of more or less positive attitudes, and that it is possible to measure, with validity, young children's attitudes toward school work. Further, it is predicted that an interaction exists between attitude and achievement in mathematics.

In order to articulate the attitude scales develope for the primary grades with those used in NLSMA,[31] attitude measures were not employed until the end of second grade, at which time the tests were administered in groups of five or six children simultaneously. Three formats were utilized in the attitude instrument (Form 2-02), the first two of which had stick figures above the statements of affect or preference read aloud by the tester; and the last displayed drawings of a series of five faces with expressions ranging from an extreme frown to a broad smile.[32] The scales developed from this test designated such parameters of attitude toward arithmetic as easy-hard, liking of the subject, and academic self-image, which encompassed motivation to do well and evaluation of his own school performance. One further scale measured the child's liking of reading as a possible measure of perference for verbal activities rather than quantitative activities.

At the end of third grade, a revised form of the second grade attitude test was administered (Form 3-03).[33] In addition, a separate attitude instrument, utilizing items from the NLSMA fourth grade "Ideas and Preferences Inventory," was administered. These items have a five- or six-point multiple choice format and are primarily positions of agreement or disagreement on the preceding statement. The scales from this test include arithmetic as being fun or dull, easy or hard; a self-concept scale; and a scale sampling anxiety about arithmetic.

<u>Retention</u>

<u>Purpose</u>. The purpose of the retention testing portion of the ELMA study[34] was to measure differential patterns of gain or loss in mathematics over the summer vacation.

---

[31] See <u>NLSMA Reports, No. 1, Part A</u>, pp. 3-22, for the "Ideas and Preferences Inventory" and <u>NLSMA Reports, No. 7</u>, Chapter 12, for a description of the rationale and procedures used in constructing this test.

[32] See <u>ELMA Technical Report No. 3</u> for the test booklet, administration instructions, and scale properties.

[33] See <u>ELMA Technical Report No. 4</u> for the test booklet, administration instructions, and scale properties.

[34] Results of the retention data analysis are not included in this report. They will be reported in a subsequent publication.

Achievement testing is generally undertaken during the spring in order to assess gains in particular subject areas over the school year. It is important to obtain end-of-year measurements of children's performance for comparison to a set of national norms and for comparison with their own performance of previous years. The question remains, however, of what happens to the gains achieved over the school year during the non-school portion of the year, i.e., the summer vacation months.

There are many factors that could be expected to influence retention. Among those most relevant to the study here reported are curriculum, socio-economic background of the sample tested, and the character of the test used. Another variable, likely related to socio-economic status but not studied, would be the nature of the children's summer vacation experiences.

Curriculum differences in retention might be attributed to differential emphasis on understanding or application of concepts between curricula, to differential amounts of drill (practice) on particular arithmetic operations, and to built-in review. Another variable predicting retention is placement of material in the text. It may well be that the principle of recency is applicable and, therefore, that the material the teacher covers toward the end of the school year is best remembered by the children when the new school year begins.

The implication of children's gains or losses over the summer are critical for both teaching and curriculum development.

Methodology. The entire ELMA population was tested in May of each of the four years of the study. In order to measure retention over the summer months, a small sample from City 1 was selected to be retested in September immediately after the opening of the schools. This latter testing was always completed within the first two weeks of the school year in order to minimize teacher review or instruction effects.

The sample selection for the end-of-kindergarten to beginning-of-grade-one testing was done through a random number program. Two-hundred twenty-seven children, selected by school and sex through random number assignment, were retested on certain parts of the K-02 test administered the previous May.

For the following two years, end of first grade to beginning of second grade, and end of second grade to beginning of third grade, the sample selection procedure differed from that previously described. Instead of selecting a random sample from the pool of all schools within each socio-economic by curriculum classification as had been done for the first retention testing, certain schools were selected from each cell and all children within those

schools were tested. The same children tested in the fall of the second grade year were retested in the fall of third grade.

The schools selected for retention testing were those most representative of the entire cell on WISC scores. In the two low socio-economic cells, only one school was selected because there was a large enough number (> 50) of children remaining in each of these schools to reach the total of approximately 200 children planned for the retention sample. In the middle socio-economic cells, however, two schools per cell were selected to reach the desired number of students.

The rationale for this change in sample selection was primarily administrative. The amount of time required to prepare for testing in each school was very large, and the efficiency of testing a small number of children in each school extremely low.[35] In order to test the full retention sample ($N \geq 200$) within the first two weeks after the opening of schools, a highly efficient operation was required.

Knowledge tested. Selection of content areas to be retested each fall from first through third grades had to be made without analysis of the spring (end-of-year) achievement test results. The overall policy, however, was to select one test from each of several areas of competence rather than concentrating on a single area. In all instances, the test selected was administered in the fall in the same form and with the same directions as administered the previous spring. No alternative forms were developed; therefore, the retention test is a re-test situation for the child.

Figure 2.1 shows the areas of knowledge included within the retention tests by year. At each year, retention testing was planned to include those concepts or operations stressed in both curricular programs. It can be seen in Figure 2.1 that comprehension and application were measured at second grade but only application was included in the third grade retention test. The comprehension scales developed from the end-of-first-grade test were based on understanding of the relationship of set manipulation to arithmetic operations. By the end of second grade, the arithmetic operations were stressed without reference to set manipulation. Thus, the ability to perform the operations directly was measured, and the area referred to as Comprehension was omitted for testing and was, therefore, excluded from the retention tests at the beginning of third grade as well.

---

[35] Given the mobility of this population, the number of children remaining in some schools by the end of the third year of the study was less than 35% of the original number.

September 1967 Beginning 1st Grade	September 1968 Beginning 2nd Grade	September 1969 Beginning 3rd Grade
Geometry	Place Value	Place Value
Counting	Computation - Addition	Computation - Subtraction
Equivalence of Sets	Number Comparison - Order	Number Comparison - Order
Ordering by Size	Comprehension	
Classifying by Shape	Application	Application
Test Behavior		

Figure 2.1. Retention Testing by Year and Topic

3. Treatment Variables

Teacher

Since particular schools were chosen for inclusion in ELMA by the administration of the two school systems involved, no selection of specific teachers could be made. The teachers assigned to the participating schools varied, therefore, on many parameters. The one control that could be exercised for the broadly-described "teacher variable" was that of training in teaching primary grade mathematics.

Inservice courses. Inservice courses were organized so that all of the teachers teaching ELMA pupils throughout the four years of the study would receive training in mathematics and applications for teaching mathematical ideas and operations to primary schoolchildren. Arrangements were made that the teachers receive credit from their respective school administrations for their participation in this course.

To achieve this goal of comparable knowledge for all the teachers, each inservice course was taught by a team composed of a mathematician and an experienced elementary school teacher with considerable knowledge of modern mathematics. The mathematician's role was to present the mathematical background underlying a given topic, and the teacher then developed possible pedagogy, including demonstrations of materials, for communicating this to the children.

A separate course was conducted for each cell in each of the two cities so that the concepts dealt with could be made more relevant to the curriculum being taught, SRA or SMSG,(36) and to the particular socio-economic group being taught.

The plan was to conduct courses during the 1966-67 school year for both the current kindergarten teachers and the first grade teachers to whom the children would be assigned the following year. Also included as participants in these courses would be aides who were to assist in the SMSG curriculum classes during kindergarten and first grade. The next courses would then be held during the 1968-69 school year for the second and third grade teachers. Some modification of this plan was made, however, because of teacher mobility and the necessity to provide for training of teachers new to the school at first and third grade who had not participated in the previous year's inservice course. Throughout the four years of the study, the only teachers not required to attend a course were those who had had training in teaching new mathematics, either in college level courses or inservice programs, during the prior three years.

By September, 1967, a number of the first grade teachers who had participated in the course conducted during the kindergarten year had left the ELMA schools. Of sixty-four first grade teachers in City 1, twelve in the two SMSG groups were new to the schools, and eleven in the SRA groups had not been in the inservice classes the previous year. In City 2, of thirty-five first grade teachers, eight were new in the SMSG cell, and three in the SRA cells. Therefore, arrangements had to be made for providing them with informal training to make their preparation equivalent to that of the teachers taught the previous year.

The inservice program, as implemented, then, included a course in 1966-67 consisting of fifteen weekly classes of one and one-half hours in length, meeting from September through January after school hours, for kindergarten and first grade teachers, plus aides in SMSG classes.

For those teachers new to the ELMA classes at first grade, 1967-68, who had not had recent courses in modern mathematics, four formal sessions were held with curriculum supervisors in each of the two cities. Again, these sessions were held separately for those teachers teaching SRA and those teaching

(36) The text used by the teams teaching the SMSG teachers was SMSG, Studies in Mathematics, Vol. XIII, Inservice Course in Mathematics for Primary School Teachers: Stanford, 1965. The text used for SRA teachers was SMSG, Studies in Mathematics, Vol. IX, A Brief Course in Mathematics for Elementary School Teachers: Stanford, 1963. Both are available from A. C. Vroman, Inc., 2085 East Foothill Blvd., Pasadena, Calif. 91109.

SMSG first grade classes. In addition, the supervisors met individually with these teachers to work with them on specific topics or applications.

Inservice training for the second grade teachers consisted of eight two-hour meetings conducted between September, 1968, and January, 1969, with classes running parallel for the two cities and two curriculum groups within each city. The format was the same as that of the 1966-67 inservice program, with a mathematician and a teacher experienced in teaching modern mathematics jointly teaching the courses.

For the third grade teachers, the format of the inservice course was the same as that conducted for the second grade teachers the previous year.

The results of a questionnaire[37] sent to each of the mathematican and teacher consultants conducting the inservice course for the kindergarten and first grade teachers suggest very similar handling of material across the seven classes (four in City 1 and three in City 2), with the mathematicians making a relatively formal presentation of a particular topic for approximately forty-five minutes to one hour. The next forty-five minutes were used by the teacher consultant to demonstrate ways of implementing this topic, including presentation of relevant games and materials. This latter portion of the meeting was likely to involve more discussion and questioning by the participating teachers. In general, the same beginning topics were covered across classes. These included sets, set comparison and operations on sets, place value, and addition. More variability in coverage occurred with such topics as the arithmetic operations of subtraction and multiplication, geometric ideas, and measurement.

<u>Teacher's use of curriculum</u>. To evaluate the teacher's use of the curriculum materials, two kinds of data were collected. First, both the kindergarten and first grade teachers were requested to complete questionnaires[38] at the close of the respective school years to provide information on the topics they had covered, their use of pupil workbooks,[39] frequency and length of mathematics instruction, and their use of the teacher aide for those classes that had the services of such an additional person.

---

(37) See Appendix 2.1 for a copy of the Inservice Consultant Questionnaire, June 1967.

(38) See Appendix 2.2A for a copy of the Kindergarten Teacher Questionnaire and Appendix 2.2B for a copy of the first grade teacher questionnaire.

(39) Since there is no pupil book for the SMSG kindergarten program, the extent of use of teacher prepared worksheets was requested from all the teachers.

The second kind of data was obtained by observations of each teacher during mathematics instruction. These observations were made by the ELMA coordinators in the two cities. Ratings were made on such variables as adherence to the curriculum, use of the particular program's teacher commentary, availability of manipulable objects to the children for mathematics instruction, clarity of presentation, use of aide, and children's involvement during instruction.(40)

These observations were made shortly after the middle of the school year in both centers to avoid the beginning and end of year conditions that may make a single observation period less typical of a teacher's instructional behavior.

Curriculum

Differences between SMSG and SRA.(41) The similarities between the two curricula studied are, in many ways, greater than the differences. Both are of the mathematics broadly labeled "new" as contrasted with "traditional." A major purpose of the Greater Cleveland Mathematics Program(42) was to develop a curriculum that could be presented in a logical way so that basic mathematical concepts would be understood before the teaching of computational schemes was undertaken. The plan of the curriculum was to make use of a discovery approach to learning.(43)

For SMSG, also, understanding of the basic concepts and structure of mathematics is central to the curriculum. Upon this understanding the use and application of mathematics rests. Proficiency in computation is predicted to proceed simultaneously with greater understanding of concepts.

---

(40) See Appendix 2.3 for a copy of the form used by the coordinators to observe and rate teachers.

(41) School Mathematics Study Group, Mathematics for the Elementary School, Books K and 1, Special Edition (Revised), Stanford University, 1966. School Mathematics Study Group, Mathematics for the Elementary School, Books 2 and 3 (Revised), Stanford University, 1965. Available from A. C. Vroman, Inc., 2085 East Foothill Blvd., Pasadena, Calif. 91109. A detailed comparison of the SMSG and SRA curricula, by topics tested, is in Appendix 2.4.

(42) This is the program published by Science Research Associates and is referred to throughout this report as "SRA" or "State" because it is the curriculum adopted for use in the elementary schools of the state in which the ELMA population was located.

Greater Cleveland Mathematics Program, California State Series 1965, K-3, Educational Research Council of Greater Cleveland, 1961-62.

(43) For a more complete description, see Deans, Edwina, Elementary School Mathematics, New Directions. Washington: U.S. Government Printing Office, 1963.

One difference between the two curricula involves the role of the teacher in using the published materials. SMSG is predicated upon greater teacher responsibility for developing practice and mathematics-related activities in the primary grades. SRA, on the other hand, provides more structure in the printed materials, particularly in the form of a large number of pupil workbook pages. For teachers using SMSG, the pupil pages provided are meant as suggestions and not intended to be the total practice experience. In this sense, teachers using SMSG are expected to do more planning and implementing of the curriculum depending upon their evaluation of pupil progress. The SMSG teacher books at the primary grades explicitly state that the order of topics presented can be varied from the order in which they are introduced in the printed materials.

A difference between the two sets of curriculum materials mentioned briefly above is the absolute number of workbook pages. SRA, in essence, provides a more structured program by its provision of extensive pupil practice pages. In addition, the workbook pages differ noticeably, with SRA consistently including more problems per workbook page. The philosophy of SMSG, in developing printed materials, was that young children's attention could be enhanced by minimizing distracting elements on a single page and that distractions could be in the form of other problems presented in proximity. Therefore, larger type and illustrations were used for each problem, and fewer examples or problems were printed per workbook page.

Aides

A notable difference between the two curricula was the employment of teacher aides in the SMSG classes to assist the teacher. Aides were considered part of the curriculum implementation since earlier work had indicated that teachers felt they could enable the learning of the SMSG curriculum at kindergarten and first grade, expecially with children from less advantaged homes, by teaching them in small groups. To better control the curriculum variable across socio-economic groups, aides were utilized in all SMSG classes as part of the instructional program.

The plan to utilize aides also included their participation in inservice training as noted earlier. Suggestions for how their services could best be used by the teachers were made by the teacher consultants at the inservice meetings.

Aides were placed in the kindergarten classes at the beginning of the second term. They assisted during mathematics instruction, generally on a daily basis for one-half hour. On the basis of a questionnaire sent to the kindergarten teachers in June, 1967, and to the first grade teachers in June, 1968,

it was reported that the aides were used primarily to work with small groups of children to reinforce work taught to the entire class by the teacher.

Other, less frequent, uses of aides were in preparing materials for instruction, in administering teacher developed mathematics tests, and working with individual pupils. In no instance reported did the aide instruct the entire class in mathematics.

Chapter 3

DESCRIPTION OF THE SAMPLE

1. Initial Selection

The sample of children included in this study was drawn from the public school systems of two cities within the same state. All children entering kindergarten in the fall of 1966 in selected elementary schools were initially part of the sample. The particular schools chosen for inclusion in ELMA were selected by administrators in each school system and were to meet four criteria:

(1) each group of schools would draw its pupils from a residential area that could be readily classified as either a lower or middle income group;

(2) within each of the two socio-economic classifications given in (1), there would be two groups of elementary schools, each group feeding into a common junior high school;

(3) within each of the two socio-economic classifications, each comparable group of schools given in (2) would agree to use a designated mathematics curriculum, either SMSG or the State-adopted SRA texts, throughout the four years of the study;

(4) within each of the two socio-economic classifications, each comparable group of schools would include no less than 200 pupils.

The outcome of the specified criteria for school selection was to achieve a two-by-two design for each city as shown in Figure 3.1.

	Curriculum	
Socio-economic Level	A SMSG Low	C State Low
	B SMSG Middle	D State Middle

Figure 3.1. Population Groups for Each City.

Within City 1, it was possible to achieve such a design. Within City 2, however, only three of the four cells could be filled. The omitted cell in City 2 was B , the SMSG middle income group.

The number of entering kindergarten children tested in the two cities in the fall of 1966 was 2,043. Of these, twenty-two were excluded from the study because the testers' ratings indicated either that they had so little knowledge of English that their school progress could not be evaluated by our testing; that they presented severe emotional or mental development problems; or that they were repeating kindergarten. The fall, 1966, test results could not be used for an additional twenty students in City 1 because of tester unreliability, although these children were continued in the study. Of the total number of children tested in September, 1966, then, 2,021 remained in the ELMA study.

Table 3.1 presents the number of schools by city and cell from which pupils were included as well as the number of pupils and percent remaining after one calendar year. It can be seen that for roughly comparable numbers of pupils, more schools are included within the middle socio-economic cells than within the lower socio-economic cells.

TABLE 3.1

Number of Schools and Pupils by City and Cell
at the Beginning of Kindergarten and First Grade

	City 1				City 2			
		Number of Pupils				Number of Pupils		
Cell	No. of Schools	Fall 1966	Fall 1967	% Remaining after K Year	No. of Schools	Fall 1966	Fall 1967	% Remaining after K Year
SMSG Low S.E.	4	366	241	65.84	4	175	126	72.00
SMSG Middle S.E.	7	384	255	66.40	-	-	-	-
State Low S.E.	3	353	221	62.60	4	196	132	67.34
State Middle S.E.	6	292	172	58.90	6	235	97	41.27
Total	20	1395	889	63.72	14	606	355	58.58

The above table further shows a smaller number of entering kindergarten children per school in City 2 than in City 1. There is an extenuating circumstance, however, that makes these numbers misleading. City 2 had a practice of half-year promotions, while City 1 did not. Therefore, children not old enough to enter kindergarten in September could enter at the beginning of the second

term of the school year. The only children from City 2 included within ELMA were those entering as beginning kindergarteners in September, 1966.

It can further be seen from Table 3.1 that between the beginning of kindergarten and the beginning of first grade only 1,244 (889 in City 1, and 355 in City 2) of the original 1,995 (1,395 in City 1, and 606 in City 2) pupils tested remained within the total sample. The loss of children was greater, however, between spring and fall of 1967 than between fall of 1966 and spring of 1967, as indicated by 1,712 of the initial number (2,021) being tested in the spring. The reason for this large loss over the summer months was attributable to the transfer of many children from kindergarten in public schools to parochial schools at first grade.

Method of Updating Student Rosters

In order to follow the original group of students through the four years of the study, each school was contacted in the fall and spring of each school year to request that our rosters of students be updated. If a child who had previously been registered in the school, at the appropriate grade level, was no longer a pupil in either that grade or school, information on the date of his withdrawal plus the reason for his being changed or leaving was requested. Table 3.2 presents the numbers of pupils lost from the ELMA study, by city, as of February, 1967, i.e., the beginning of the second term of the kindergarten year, by the reasons for being dropped. This table illustrates the reasons for dropping given by the schools in the yearly roster updates.

It is apparent that the frequencies in various categories will change from year to year. For example, there were no children at the second term of the kindergarten year in the category "Repeating Same Grade," although there were in later years.

The first two categories in Table 3.2 indicate the mobility of the urban populations from which the ELMA sample was drawn. The rate of transfer from one school to another for this particular group over the six-month period noted is 7.6% for City 1 and 8.2% for City 2. The changes in the original sample over the course of the four years of the study will be dealt with in detail in the next section.

The relatively high frequency (N = 14) in the category "Promoted to a Higher Grade," for City 2, reflects the mid-year promotion policy of that city noted earlier.

It should be noted that if a child moved from the school in which he was initially enrolled to another included within ELMA and also within the same city and cell, he was kept in the sample.

TABLE 3.2

Number of Pupils Dropped by Second Term of Kindergarten Year, By City

Reason for Drop	City 1	City 2
Transfer to a School Not Included in ELMA	96	49
Transfer to a School in a Different Cell in ELMA	10	0
Promoted to a Higher Grade	3	14
Repeating Same Grade	0	0
Sent Home - Immature or Too Young	3	0
Language Problem	7	0
Eliminated - No Reason	4	1
TOTAL	123	64

2. Loss of Sample Over Time

An approximate 30% loss of the original sample during the course of this four-year longitudinal study was expected, given the mobility of the urban U.S. population. By the fall of 1967, one year after the study had begun, however, only 63.7% of the sample remained in City 1 and 58.6% in City 2.

Table 3.3 presents the numbers of original students remaining within the sample over the four years of the study. The numbers given are the children tested at the end of each school year; therefore, the N's for the kindergarten year columns will be smaller than shown in Table 3.1, which presented the beginning-of-kindergarten-year samples.

An effort was made to test all children remaining in each school at every testing period. Table 3.3, therefore, shows the number of children actually remaining in ELMA at the end of each successive school year. With the exception of one school that dropped out of the study from Cell C of City 2 between

TABLE 3.3

Number of Original Pupils Tested
at End of Each School Year,
by City and Cell

	City 1					City 2				
Cell	Kndgtn	First Grade	Second Grade	Third Grade	% Remaining thru Study	Kndgtn	First Grade	Second Grade	Third Grade	% Remaining thru Study
SMSG Low S.E.	304	199	150	121	39.80	141	108	84	52	36.88
SMSG Middle S.E.	347	245	184	153	44.09	-	-	-	-	-
State Low S.E.	290	195	128	103	35.52	152	96	60	27*	17.76
State Middle S.E.	245	144	117	93	37.96	162	88	76	59	36.42
Total	1186	783	579	470	39.63	455	292	220	138	30.33

*One school in this cell dropped out of ELMA after second grade.

the second and third grade year, all cell N's are based on the number of schools as shown in Table 3.1. Table 3.3 further shows the percentages of original pupils remaining for the entire four years of the study in each cell of the two cities. It can be seen that more than one-half of the sample was lost in every cell and, in most instances, the remaining group was but slightly larger than one-third of the original group who had been tested at the end of the kindergarten year.

3. Addition of New Pupils

Because of the rapid rate of loss, 761 new students were added to the study, in City 1 only, in March of the first grade year. This new sample consisted of all children enrolled at first grade in the schools included in ELMA but who were not in the original sample. Thus, these children had transferred into the ELMA schools either during the kindergarten year or during the first

term of first grade. Of these, 595 were tested at the end of first grade and, therefore, continued within ELMA, as can be seen in Table 3.4.

If the "Percentage Remaining" column, as shown in Table 3.4, is compared with the equivalent column for City 1 in Table 3.3, the percentages look quite similar. It must be noted, however, that these figures are based on three years for the original pupils and two years for the new students. Therefore, the percentage of loss appears to be somewhat higher for the new pupils. In the analyses reported in ELMA Report No. 2, the "longitudinal sample" includes only original pupils, selected from those children who were in ELMA throughout the full four years, thus excluding the new pupils added in grade one. The "selected sample" does include children added in grade one.[44] No analyses of City 2 data are included in Report No. 2.

TABLE 3.4

Number of New Pupils Added During First Grade and Tested at End of Each School Year, by Cell for City 1

Cell	Kndgtn	First Grade	Second Grade	Third Grade	% Remaining thru Study
SMSG Low S.E.	-	108	65	38	35.18
SMSG Middle S.E.	-	169	105	78	46.15
State Low S.E.	-	152	86	55	36.18
State Middle S.E.	-	166	102	66	39.76
Totals	-	595	358	237	39.83

(44) The basis of selection of schools for both the longitudinal and the selected sample is discussed in ELMA Report No. 2.

Further, it can be seen from Table 3.4 that the total number of pupils added who remained through third grade (N = 237) was about one-half (N = 470) of the original pupils remaining in City 1 through third grade. A comparison of the original and new pupils on the WISC is presented in a later section of this chapter.

4. Qualitative Changes in Original Sample

With the rapid mobility of the research sample, the question arose as to whether selective migration was occurring. The population in certain neighborhoods in many urban centers is changing rapidly with a movement to the suburbs of more affluent sections of the population and an in-movement of groups to the vacated housing from more densely-settled parts of the urban centers. To ascertain whether the children remaining each year were significantly different on an independent variable from the sample who started out in ELMA, the mean WPPSI scores of the original sample in City 1 were compared with the mean of all the children remaining each successive year. In the tables and discussions to follow, the WPPSI scores referred to are those obtained from the administration of this test during the kindergarten year.

Table 3.5 presents the means and standard deviations of WPPSI scores for all of the original pupils in City 1, by school, remaining in ELMA for each year of the study. The WPPSI scores used are the Short Form Total Scaled Scores. For the school means, the differences in scores between kindergarten and third grade are within two IQ points, with the exception of two schools. School 4 showed a decrease of 2.3 between kindergarten and third grade, and School 9 showed an increase of 3.4 points.

The results of t-tests performed, by cell, on the scaled scores of the four subtests of the WPPSI separately, the Verbal and Performance Scaled Scores, and of the Short Form Total Scaled Score are shown in Table 3.6.

In Table 3.6, N1 is the original sample in City 1 who remained through third grade. N2 denotes those children in the original sample at kindergarten who did not remain beyond kindergarten. The column labelled "WPPSI Scales" presents, by scale number, the scaled scores for the subtests, Vocabulary (M112), Similarities (M114), Picture Completion (M117), Block Design (M120), and consecutively, the Short Form Verbal Scaled Score (M121), The Short Form Performance Scaled Score (M122), and the Short Form Total Scaled Score (M123). None of the values of t are significant which indicates that the character of the original sample did not change, as measured by this variable, between the beginning and end of the four years with the high mobility noted. It further

TABLE 3.5

Means and Standard Deviations
of WPPSI Short Form Total Scaled Scores
by School, Cell, and Grade - Original Pupils, City 1

School Number	Kindergarten			First Grade			Second Grade			Third Grade		
	M	σ	N	M	σ	N	M	σ	N	M	σ	N
SMSG, Low S.E.												
10	35.4	8.0	88	34.6	7.5	59	35.1	6.6	45	35.0	7.0	35
14	34.7	6.7	52	34.3	7.2	39	34.0	6.4	28	33.6	6.6	22
15	38.6	8.4	47	36.6	9.0	24	38.1	8.5	15	39.0	9.0	12
20	37.2	7.5	110	38.3	7.5	73	38.2	7.9	60	38.5	8.0	51
Total			297			195			148			120
SMSG, Mid S.E.												
1	40.9	7.3	76	41.5	6.9	50	42.1	6.6	33	40.9	5.3	24
3	45.2	6.7	44	44.2	7.5	29	44.6	8.8	20	43.6	9.2	16
5	42.9	6.4	56	42.3	6.2	42	41.8	6.1	35	41.5	6.1	33
6	43.3	6.8	32	42.8	7.4	22	43.2	6.9	18	44.1	6.5	12
12	50.0	7.1	31	50.1	7.2	24	51.7	7.2	13	51.8	7.6	12
13	43.4	7.4	59	42.9	7.5	44	43.6	6.7	35	44.6	6.5	28
19	45.9	6.9	36	46.5	7.0	29	46.8	7.1	26	46.1	7.0	24
Total			334			240			180			149
State, Low S.E.												
2	39.3	7.3	96	38.4	6.3	67	38.6	6.1	43	39.3	6.1	33
7	38.6	7.8	81	38.4	6.0	47	38.2	6.4	30	37.8	6.1	23
18	35.7	6.4	96	35.7	6.4	77	36.7	6.4	52	37.4	6.5	44
Total			273			191			125			100
State, Mid S.E.												
4	43.9	6.6	43	43.6	7.3	33	42.3	7.8	25	41.6	7.7	23
8	39.4	7.1	29	39.8	7.0	20	38.4	7.3	14	38.4	6.3	9
9	42.5	7.8	66	44.2	8.1	31	44.5	6.3	32	45.9	6.1	21
11	45.5	5.1	22	45.3	5.1	21	45.1	4.7	17	44.8	4.7	16
16	44.7	8.3	25	44.2	8.8	14	41.6	5.8	9	42.7	4.9	7
17	41.8	7.8	30	42.1	7.5	21	42.3	8.1	17	43.0	8.1	14
Total			215			140			114			90

TABLE 3.6

Student's t-Test
of WPPSI Scaled Scores by Cell -
Original Pupils at Kindergarten
and Remaining at Third Grade, City 1

WPPSI Scales	N1	Mean N1	SD N1	N2	Mean N2	SD N2	t
SMSG, Low S.E.							
M112	120	8.50	2.41	102	8.80	2.62	-0.8946
M114	120	9.70	2.78	102	9.49	3.01	0.5354
M117	120	8.73	2.66	103	8.94	2.55	-0.5970
M120	120	9.67	2.55	103	9.84	2.43	-0.5321
M121	120	18.20	4.40	102	18.29	4.76	-0.1528
M122	120	18.40	4.47	103	18.79	4.03	-0.6781
M123	120	36.60	7.79	102	37.06	7.64	-0.4420
SMSG, Mid S.E.							
M112	149	11.17	2.94	94	11.40	3.27	-0.5551
M114	149	10.58	2.65	95	10.73	2.69	-0.4035
M117	149	10.78	2.56	95	10.58	2.55	0.5956
M120	149	11.46	2.44	95	11.13	2.79	0.9434
M121	149	21.76	4.74	94	22.17	4.95	-0.6429
M122	149	22.23	4.15	95	21.71	4.05	0.9879
M123	149	43.99	7.23	94	43.90	7.39	0.0922
State, Low S.E.							
M112	100	8.97	2.56	83	9.67	2.88	-1.1734
M114	100	9.79	2.67	84	9.80	2.79	-0.0197
M117	100	9.20	2.48	84	9.56	2.38	-1.0039
M120	100	10.17	2.49	83	9.83	3.33	0.7672
M121	100	18.76	4.28	83	19.49	5.00	-1.0556
M122	100	19.37	3.84	83	19.45	5.03	-0.1130
M123	100	38.13	6.28	82	39.01	8.99	-0.7507
State, Mid S.E.							
M112	90	10.40	2.51	71	10.38	3.17	0.0435
M114	90	10.83	2.94	71	10.15	2.95	1.4501
M117	90	10.59	2.60	71	10.11	2.53	1.1694
M120	90	11.33	2.26	71	11.20	2.64	0.3452
M121	90	21.23	4.44	71	20.53	5.12	0.9107
M122	90	21.92	4.09	71	21.31	4.17	0.9326
M123	90	43.16	6.84	71	41.85	7.60	1.1353

supports the interpretation that the population mobility did not operate as a selective factor on this general ability measure.

5. Differences between Original and New Samples

In order to ascertain whether the new pupils added in first grade performed differently from the original pupils and, further, whether a selective factor was operating in the loss of new pupils, Tables 3.7 and 3.8 are presented. As with the analysis of sample changes in WPPSI scores, these analyses of changes in WISC scores refer to a single administration of the WISC. The WISC was given to all the children in City 1 during the second grade year.

Table 3.7 gives the means and standard deviations of the WISC Short Form Total Scaled Scores (M311) for the original pupils at second and third grade and for the new pupils at these grades, by school.

Two observations may be made in studying this table. First, in comparing the scores for the original and new pupils at second grade, in all but three of the twenty schools, the mean of the original pupils is higher than that of the new pupils although the absolute differences may be small. Second, in noting the direction of change in mean IQ by school between second and third grade, there is little difference in the direction of change between the original and the new pupils. For both groups, there is a tendency for the pupils remaining at third grade to have slightly lower WISC scores than the group tested at second grade. This decrease in school mean occurs in twelve schools for the original pupils, and in twelve schools for the new pupils as well. With the exception of two schools (2 and 18 for the original pupils), the schools in which mean scores are higher at third grade than at second, for both the original and new samples, are in the middle socio-economic cells.

Table 3.8 presents the results of t-tests performed, by cell, between the original and new pupils remaining through third grade on the scaled scores of the WISC. The scaled scored subtests are Vocabulary (M305), Similarities (M306), Picture Completion (M307), and Block Design (M308). The remaining three scales in the table are the short form Verbal Scaled Score (M309), the short form Performance Scaled Score (M310), and the WISC Total Scaled Score (M311). The t-values show significant differences between the original pupils and new pupils who remained throughout the third grade, with the original pupils (N1) consistently showing higher means than the new pupils (N2) added at first grade, although these differences are more noteworthy in the State curriculum cells than in the SMSG curriculum groups. For the lower socio-economic SMSG

TABLE 3.7

Means and Standard Deviations
of WISC Short Form Total Scaled Scores
by School, Cell and Grade -
Original and New Pupils, City 1

School Number	Original Pupils: Second Grade M	σ	N	Original Pupils: Third Grade M	σ	N	New Pupils: Second Grade M	σ	N	New Pupils: Third Grade M	σ	N
SMSG, Low S.E.												
10	39.0	6.2	46	38.3	5.0	36	37.0	6.7	24	37.0	6.5	13
14	36.9	6.7	28	36.7	7.0	22	36.9	6.3	24	35.4	5.6	17
15	42.1	8.6	16	42.0	7.0	12	35.2	4.3	6	32.5	2.1	2
20	39.5	6.9	59	39.4	7.1	51	37.7	6.4	9	37.4	6.3	5
Total			149			121			63			37
SMSG, Mid S.E.												
1	43.6	7.5	33	42.6	6.8	24	41.5	6.8	13	41.3	8.0	6
3	45.2	8.0	19	45.1	7.5	15	45.1	8.4	11	45.6	8.6	10
5	48.5	8.7	36	48.7	8.9	34	48.3	7.2	18	48.9	7.4	16
6	48.9	8.2	19	49.8	8.8	13	46.1	8.3	11	49.8	5.0	4
12	53.9	6.3	12	55.1	5.1	11	49.5	8.3	11	48.6	8.1	10
13	51.3	8.4	35	52.2	8.5	28	41.9	9.1	13	41.3	12.0	7
19	53.8	9.2	27	52.9	8.8	25	52.3	7.2	22	52.2	7.5	20
Total			181			150			99			73
State, Low S.E.												
2	40.9	7.9	43	41.1	8.8	33	37.4	9.3	37	35.0	6.7	24
7	39.4	7.0	30	39.0	6.3	23	41.4	7.9	17	38.5	7.2	10
18	38.3	7.3	54	38.5	7.5	47	36.1	7.6	28	36.1	7.4	20
Total			127			103			82			54
State, Mid S.E.												
4	41.1	7.5	23	40.2	7.1	21	40.4	7.0	13	40.2	6.6	9
8	40.6	6.6	15	40.3	6.4	10	37.8	5.1	35	38.4	5.2	23
9	47.3	7.4	33	47.9	8.3	22	39.9	7.2	15	42.2	6.8	10
11	50.4	6.2	17	49.9	6.1	16	51.0	9.7	9	53.0	8.3	6
16	48.4	9.7	9	50.7	7.8	7	47.6	9.5	13	44.6	7.7	8
17	47.6	8.3	16	47.2	7.8	13	41.6	4.8	11	42.9	5.0	8
Total			113			89			96			64

TABLE 3.8

Student's t-Test
of WISC Scaled Scores by Cell -
Original and New Pupils
Remaining through Third Grade, City 1

WISC Scales	N1	Mean N1	SD N1	N2	Mean N2	SD N2	t
SMSG, Low S.E.							
M305	120	9.49	2.42	38	9.05	2.54	0.9407
M306	120	10.27	2.59	38	9.74	2.37	1.1745
M307	120	9.33	2.36	38	7.61	2.64	3.6044****
M308	120	9.78	2.32	37	9.59	2.33	0.3270
M309	120	19.76	4.26	38	18.79	4.13	1.2508
M310	120	19.11	3.79	37	17.24	4.10	2.4735***
M311	120	38.87	6.62	37	36.08	5.85	2.4616***
SMSG, Mid S.E.							
M305	148	12.74	3.11	75	12.47	3.21	0.6123
M306	148	13.25	3.29	75	12.43	3.08	1.8420*
M307	147	11.06	2.75	75	10.89	2.42	0.4661
M308	147	12.03	2.95	74	11.86	3.01	0.3797
M309	148	25.99	5.60	75	24.89	5.68	1.3730
M310	147	23.09	4.76	74	22.84	4.49	0.3830
M311	147	49.07	8.69	74	47.85	8.72	0.9856
State, Low S.E.							
M305	102	9.32	2.93	55	8.44	2.72	1.8985*
M306	102	10.58	3.02	55	9.64	2.54	2.0702**
M307	102	9.47	2.68	55	8.69	2.32	1.9055*
M308	102	10.03	2.84	54	9.13	2.60	1.9891**
M309	102	19.90	5.08	55	18.07	4.41	2.3475**
M310	102	19.50	4.50	54	17.87	4.18	2.2546**
M311	102	39.40	7.72	54	36.02	7.03	2.7612****
State, Mid S.E.							
M305	87	12.18	3.37	66	10.82	2.71	2.7813****
M306	87	11.76	2.88	66	10.17	3.15	3.2147****
M307	87	10.23	2.28	65	9.66	2.49	1.4375
M308	87	11.91	2.59	65	11.32	3.32	1.1790
M309	87	23.94	5.47	66	20.98	4.95	3.5000****
M310	87	22.14	3.96	64	20.95	4.18	1.7584*
M311	87	46.08	7.99	64	41.95	7.36	3.2824****

* .05
** .02
*** .01
**** .005

population, the only subscale on which the two samples differ is Picture Completion (M307) and this, in turn, contributes to the significant differences found in the Performance Scaled Score (M310) and in the Total Scaled Score (M311). Again, in the SMSG middle socio-economic group there is but one significant difference, this time on a verbal scale, Similarities (M306). This difference is not large enough, however, to make for significant differences in the verbal or total scores.

The pattern of significant differences is not consistent for the two State populations since the original and new pupils in the low socio-economic group are different on both verbal and performance subtests while the middle socio-economic State pupils differ only on verbal subtests. Given the above statement, it should be noted, however, that a significant difference is seen between the original and new pupils within the State middle socio-economic group on the Performance Scaled Score (M310), as well as on the Verbal (M309) and Total Scaled Score (M311), despite the lack of difference on the two performance subtests contributing to the performance score.

It appears, then, that some selective factor was operating in the mobility of populations, particularly into those neighborhoods from which the State samples were drawn, using the WISC as a criterion.

Chapter 4

FACTOR ANALYSES OF KINDERGARTEN SCALES

1. Description of Scales

Mathematics Test Batteries

The initial test battery given in September of the kindergarten year, referred to as K-01, was planned as an evaluation of readiness for learning mathematical concepts. K-02, given in May, was planned to assess gain over the school year. Both K-01 and K-02 were individually-administered inventories. The decision to develop and use individually administered tests had been made during the previous pilot testing period[45] after reviewing published group-administered tests of mathematics achievement available for kindergarten and grade one. The judgment was made that the group tests demand that the children give careful selective attention to a directed portion of a complex printed page (albeit pictorial representations rather than words), that they be able to follow somewhat difficult verbal instructions directed to the entire group, and that they be able to make responses to these directions by manipulating a crayon or pencil in an appropriate manner. Since these skills tend to be less well developed in children from disadvantaged backgrounds, their performance on the test is likely to be adversely affected by the test format and situation, apart from their competence in handling the substantive material.

K-01 and K-02 were developed to minimize possible differential between disadvantaged and more advantaged children in handling the test situation and materials. The tests were devised so that the children responded, in most tasks, to concrete materials. When printed drawings were employed as test materials, they were used as parallel forms to those tests utilizing concrete objects. Verbal directions given by the tester were brief, simple statements, and verbal responses were necessary in few of the test items. For those items requiring the children to make a verbal response, a single word or short phrase was sufficient.

Although each test took about forty minutes to administer, both the task and the materials varied frequently during this period of time. Thus, the requirement of a long attention span for good performance on K-01 and K-02 was

(45) Leiderman, Chinn, & Dunkley, *op. cit.*, p. 7.

considerably reduced.

All of the tasks included within the K-01 inventory were given to every child within the study sample. For K-02, however, certain tasks were given to all of the children, and each of the remaining tasks was given to one-fourth of the group (designated by the letters W X, Y, and Z). This procedure was necessary since the length of the test was approximately doubled because of extending certain tasks, developing parallel forms, and adding new tasks to the K-01 inventory.

Cognitive process measures. Several tasks within the K-01 and K-02 inventories were used as indices of cognitive processes. These were color - matching, naming, and identifying; classifying; ordering; geometric shapes - matching, naming, and identifying; vocabulary; visual memory; and conservation. The color inventory was included only in K-01 and conservation included only in K-02. All of the others were given both at the beginning and end of the school year.

We assume that abstract concepts develop partly through awareness of certain regularities of events and, later, the categorization of these regularities. At the level of the five-year-old, such physical attributes of objects as size, shape, and color are used to systematize and categorize a wide range of perceptual experiences. The matching portions of the Color (019)[46] and Geometric Shapes (001) tasks were employed solely as perceptual tests to ascertain whether the children were able to match two cards embedded within two displayed sets of cards on the basis of shape or hue alone. The matching tasks were not repeated in the K-02 battery since they proved to be too easy for the children at the beginning of kindergarten.

The naming portions of these same tasks required the children to give names to specific colors (020) and simple geometric shapes (002 and 102Y). Accurate performance on these items depends upon the children's experience in having had a particular label (e.g., red or circle) consistently attached to a particular hue or shape, and being able to say that word when the appropriate perceptual stimulus is presented. The naming section was always given

[46] Throughout the discussion of factor analyses, specific scales developed from the tests administered will be referred to by a number in parentheses. Those scales with numerals only refer to SMSG-developed tests. Those scale numbers preceded by "M" refer to general ability test scales (e.g., WPPSI); those preceded by "R" refer to readiness test scales; and those preceded by "A" refer to achievement test scales. When the scale number is followed by the letter W, X, Y, or Z, it refers to the appropriate parallel form administered in the K-02 inventory.

before the identifying so that the child would have to provide the color and shape names which were provided by the tester in the identifying section.

The identifying portions of the Color (021) and Geometric Shapes (003 and 104) tasks required the children to identify and select a color or shape requested by the tester from a displayed set. This task demands, in addition to having the particular color or shape name attached to certain perceptual stimuli, that the child "kee mind" the requested object while scanning the presented set to locate th priate object, whose only property differentiating it from the others is its lor or shape, according to the specific task.

The ordering and classifying tasks required that the child rely on perceptual cues, and in addition, that he have certain concepts of shape and of size relationships. The difficulty of the classifying items was varied by the number of attributes upon which classification was required. In K-01, the test materials for both Ordering (014) and Classifying (015) were geometric shapes of varying size and color. In K-02, Ordering (147) required the child to arrange by size a series of objects, of pictures, and of geometric shapes. Classifying (129Y) in K-02 had items using objects and pictures as materials as well as the shapes that were used in the Classifying scale in K-01. The items of Classifying (129Y) were regrouped to form two additional scales. Classifying S-2 (130) was given to all the children and included items that required the children to hand the tester the smallest or largest object ordered for Scale 147. The remaining items in Scale 129Y (administered only to Sample Y) were designated as Classifying S-1 (128Y).

Two kinds of mediating processes that appear necessary for symbol manipulation, and that were measured as cognitive process variables, were vocabulary and visual memory. When the child is able to manipulate words and visual images representing objects or experiences, rather than having to have the concrete object in his presence, then he is better able to use his experiences for more abstract symbolic thinking.

Although there are many facets of language learning relevant to cognitive development, the most relevant for the ELMA study was the vocabulary necessary for understanding mathematical concepts and relationships. Mathematics has a precise language. At this age level, however, perhaps more important than the precise language of mathematics, is some vocabulary which the children can use as labels for certain manipulations. In developing the concept of sets, for example, such expressions as "more than," "fewer than," and "as many as" are crucial. For the early pre-geometry ideas, such words as "inside," "outside," and "on" are needed. The ability to understand these words, as shown by appropriate manipulation of blocks, was the means used to assess the vocabulary of

the kindergarten mathematics program (010 and 117X).

Our definition of visual imagery is the mental representation of objects and actions that stand for actual objects or events experienced by the child, and that can be manipulated in thought, as a step beyond the necessity of manipulation of the concrete, here-and-now events.

The usefulness of visual imagery in concept performance is a moot issue, but as Bruner[47] states, "The concentration upon surface properties of the environment and the conservation of these properties through imagery seem to constitute a state of growth that bridges the gap between the rigid serial representation of earlier enactive representation and the language-saturated phase of later childhood ... ." (Ibid, p. 28).

The measurement of visual memory within the K-01 and K-02 batteries was through recall and recognition responses to a removed object that the child had been shown. To minimize the possibility of disadvantaged children not succeeding on this task because of a language handicap, simple familiar objects such as a toy car or dog were used in the form which will be referred to as Visual Memory - Objects (008 and 114W). In the parallel form, denoted as Visual Memory - Pictures (017 and 131Z), drawings of familiar objects were used. In K-02, two additional visual memory tests were included, Visual Memory - Picture Cards (133W) and Visual Memory - Shapes (135W).

Ability to conserve number was measured in a test modeled after one devised by Herbert Zimiles.[48] Conservation (146) measured the child's ability to recognize equalities and inequalities between two sets when conflicting perceptual cues were present. To achieve correct answers, the child had to disregard spatial arrangement and size of set members, which sometimes conflicted perceptually with number, and to utilize number only. The task required in this conservation-like scale was to determine in which of two rows on a card there were more pictures, or whether there was the same number in both rows. Test materials were dots, shields, and flags.

<u>Mathematics achievement measures</u>. The separation of those tests identified as "Cognitive Process Variables" from those included as "Mathematics Achievement Measures" was somewhat arbitrary; the two are clearly not disjoint sets. The

[47] Bruner, J. S., Olver, Rose R., Greenfield, Patricia M., et al., <u>Studies in Cognitive Growth</u>, New York: John Wiley & Sons, Inc., 1966.

[48] Zimiles, H. The development of conservation and differentiation of number. <u>Monogr. Soc. Resch. Child Development</u>, 1966, <u>31</u>, No. 6.

major criterion for calling a specific task a measure of cognitive process was that, in addition to being a learned relationship or understanding, its presence indicates a certain level of cognitive development.

Those tasks here called mathematics achievement measures included counting objects and counting members of a set, forming equivalent sets, numeral writing and identification, and ordinal number.

Cardinal counting was assessed in two different ways. In the first, the child was asked to count out a specified number of buttons from a large set of buttons provided him, Counting Buttons (004 and 106X). In the other type of task, the child was provided a set whose members he had to count. For the scales Counting Members of a Given Set - Picture Cards (006 and 110), each set consisted of pictures on a card. Counting Members of a Given Set - Objects (111), which was included only in K-02, had objects stapled on a card in each set.

Manipulation of set materials prior to operations on numbers is the approach used in both the SMSG and SRA kindergarten books. Among the activities included is that of set comparison employed to establish the concept of equivalence and to provide practice with the vocabulary and the idea of sets having more or fewer members. This activity, in turn, leads to work with numbers greater than, equal to, and less than other numbers. Some of the set comparison ideas were assessed in the vocabulary test discussed previously.

The concept of equivalence was tested in both K-01 and K-02. In K-01 it was tested by requesting the child to form a set equivalent to that represented by a group of pictured dots on a card, Equivalent Sets - Dots (012). In K-02 it was retested in this form (119). In addition, a parallel form was included in K-02, with the given set consisting of concrete objects presented in the same patterns as were the dots on the cards, Equivalent Sets - Objects (118).

To compare sets and arrange them by the number of members within each set, it is useful, though not imperative, for the child to have some concept of ordinal number. The vocabulary of ordinality is part of the everyday language of the kindergarten teacher, e.g., taking turns, the first child in line, and references to the sequencing of activities during the school day. The meaning of "first," "fourth," etc., may be more explicitly taught through the ordering of sets by the number of members contained within each set or through establishing and naming positions of objects within a set. Ordinality was tested apart from cardinality by requesting the child to place marbles in specified (e.g., second) toy trucks that were lined up in front of him, Ordinal Number (013 and 120).

The ability to write and to identify numerals is a clear prerequisite for work in mathematics. A certain amount of eye-hand coordination is necessary for a five or six-year-old to be able to form numerals. In order to identify them, he must have a number name associated with the written symbol. The explanation for the identification portion of this task was so phrased that the numeral the child had to identify stood for the number of discs within a sealed envelope on the front of which the numeral was printed, Identification of Numerals (007 and 113X). On the numeral writing portion the child was asked to write the numeral that showed how many buttons were in a box, Writing Numerals (005 and 108X).

The ability of a young child to concentrate on a task and to respond to directions given him by an adult can be expected to affect performance in school as well as in a testing situation. To obtain some index of these behaviors, two scales were rated by the testers administering K-01 and K-02. Response to Verbal Directions (022 and 143) was a rating of the child's attempted or actual compliance with the directions given him. Attention to Tasks (023 and 144) was a rating of the child's ability to attend without losing interest or needing reminders.

Intelligence and readiness tests. The verbal tests of the WPPSI included in the short form administered during the kindergarten year were Vocabulary (M112) and Similarities (M114); Picture Completion (M117) and Block Design (M120) were the two performance tests. The Vocabulary subtest measures the child's knowledge of the meaning of a series of twenty-two progressively more difficult words, with a maximum score of 44. The Similarities test consists of ten items in which the child must complete simple analogies and an additional sixteen items in which he must explain ways that two objects named are alike. The maximum score on Similarities is 22.

The Picture Completion test contains twenty-three pictures each of which has some part missing. The child must name or otherwise clearly indicate he knows the missing portion. The maximum score is 23. Block Design consists of ten designs that the child must construct with blocks. In the first seven designs, the tester constructs models which the child than attempts to reproduce. On the last three items, the child must construct the designs from printed models. The maximum score for the Block Design test is 20 points.

The Metropolitan Readiness Tests were designed to measure the development, in beginning school students, of skills and abilities that contribute to readiness for instruction in first grade. The first of the six subtests included is Word Meaning (R201), a sixteen-item picture vocabulary test, in which the child marks the picture that illustrates a word named by the tester.

Listening (R202) is a sixteen-item test of ability to comprehend phrases and sentences. The child selects from three pictures the one showing a situation described by the tester. Matching (R 's a fourteen-item test of visual perception involving recognition of si ities. The child marks one of three pictures that matches a given picture. Alphabet (R204) is a sixteen-item test of ability to recognize lower-case letters of the alphabet. The child must mark, from four alternatives, the letter named by the tester. Numbers (R205) is a twenty-six item test of number knowledge and includes items relating to counting, money, numeral recognition, size concepts, and telling time. The last subtest,[49] Copying (R206), is a fourteen-item test that measures both visual perception and motor control. The task is copying letters, numerals, or geometric designs.

2. Results of Factor Analyses

Factor analyses were performed separately for each of the two individually-administered test batteries given in kindergarten, the K-01 test given at the beginning of the year and the K-02 test given at the end of the year. These analyses are based on the City 1 sample only. In some of the factor analyses, scales were also included from the WPPSI and the MRT.

In all factor analyses described in this report, the squared multiple correlation was used in the diagonal of the correlation matrix and the Varimax method was used to obtain simple structure with orthogonal factors.[50] The number of factors rotated was determined by using either the criterion that the number of factors equalled one-half the number of variables or that the eigenvalue was ≤ 1, whichever number was smaller. In the tables which show factor loadings, all loadings less than .30 have been omitted. Factors are not included in the tables unless they have at least two variables with loadings of .30 or higher. In the tables within this chapter and Chapter 5, the original factor numbers obtained in the IBM printouts have been retained. In the tables of Appendices 4 and 5 which show the reduced correlation matrices, the squared multiple correlations are given in the diagonal, and product moment correlations are shown in the remainder of each table.

---

(49) A seventh test, Draw-a-Man, is optional and was not administered by City 1.

(50) For a description of the computer program used to compute factor analyses, see BMD03M - General Factor Analysis in Dixon, W. J. (Ed.), "BMD Biomedical Computer Programs," University of California Publications in Automatic Computation, No. 2. Berkeley: University of California Press, 1970, pp. 169-180.

Factor Analyses of Beginning-of-Kindergarten Scales

Two factor analyses were performed for the scales from the beginning-of-kindergarten test battery (K-01). In the first of the factor analyses discussed below, only the scales from K-01 are included. Only children who were still present at the end of kindergarten were included in this analysis. In the second factor analysis, scales from the WPPSI and from the MRT are included. together with the scales from the K-01 test. Although the WPPSI was given during the second half of the kindergarten year and the MRT was given at the beginning of first grade, these two tests were included with the beginning-of-kindergarten mathematics scales to provide a picture of the relation between the mathematics scales and scales measuring more general abilities.

Factor analysis of K-01 battery. The number of items included in each scale and the means and standard deviations obtained for the sample are given in Table 4.1A. The number of items in the scale is equal to the maximum score attainable for all scales except Rote Counting (016), Response to Verbal Directions (022), and Attention to Tasks (023). For Rote Counting, a code was used to indicate how far the child could count without error: 0 represented less than 10, 1 represented 10-19, etc. Response to Verbal Directions and Attention to Tasks were four-point rating scales, with a 1 representing non-compliance on the former scale, and full attention on the latter scale. For the remaining scales, a score of 1 was given for each correct item, and the scale score was the total of the correct responses.

As can be seen by inspection of the statistics in Table 4.1A, the average score obtained was very close to the maximal possible value (less than one standard deviation from the maximum) for Geometric Shapes - Matching (001), and for the three scales measuring knowledge of colors (019, 020, and 021). For all scales except Geometric Shapes - Naming (002) and the Visual Memory scales (008 and 017), the values obtained for Cronbach's alpha[51] were greater than .60. For Geometric Shapes - Naming, $\alpha = .58$; and for Visual Memory - Objects and Visual Memory - Pictures, $\alpha = .43$ and $\alpha = .38$, respectively.

Factor loadings for scales of the K-01 test battery are shown in Table 4.1B. The last row of the table shows the percent of total variance accounted for by the factor. The correlation matrix on which this analysis is based is given in Appendix 4 in Table A4.1.

(51) Cronbach, L. J. Coefficient alpha and the internal structure of tests. Psychometrika, Sept. 1951, 16, pp. 297-334.

TABLE 4.1A

Means and Standard Deviations for Scales Used in Factor Analysis of Beginning-of-Kindergarten Scales
Total Sample

K-01 Scales		Item N	MN	SD
Geom Shape: Match	001	4	3.83	0.58
Geom Shape: Name	002	4	1.45	1.15
Geom Shape: Ident	003	4	2.49	1.25
Count Buttons	004	7	4.40	2.56
Write Numerals	005	7	1.04	1.92
Count Set: PC	006	8	4.15	2.90
Ident Numbers	007	8	4.49	3.02
Vis Memory: Obj	008	5	3.21	1.27
Vocabulary	010	20	14.82	2.94
Equiv Sets: Dots	012	6	3.16	2.13
Ordinal No.	013	8	3.64	1.82
Order Geom Shapes	014	2	0.83	0.86
Classify	015	9	4.29	1.98
Rote Counting	016	1	1.53	1.60
Vis Memory: Pict	017	4	1.12	1.04
Color: Match	019	6	5.87	0.58
Color: Name	020	7	5.87	1.83
Color: Ident	021	6	5.21	1.60
Resp Verb Dir	022	1*	3.66	0.57
Attn to Tasks	023	1**	1.63	0.91

N = 1,058

*Test behavior scored on a 4-point scale, with 4 as high.
**Test behavior scored on a 4-point scale, with 1 as high.

Table 4.1B

Factor Loadings for Beginning-of-Kindergarten Scales
Total Sample

K-01 Scales		Factors 1	2	3	4	5	7
Geom Shape: Match	001					.32	
Geom Shape: Name	002				.60		
Geom Shape: Ident	003				.58		
Count Buttons	004	.65					
Write Numerals	005	.59					
Count Set: PC	006	.48					
Ident Numbers	007	.68					
Vis Memory: Obj	008						.34
Vocabulary	010	.39			.30		
Equiv Sets: Dots	012	.40		.30			
Ordinal No.	013	.60					
Order Geom Shapes	014	.38					
Classify	015	.44			.36		
Rote Counting	016	.63					
Vis Memory: Pict	017						.32
Color: Match	019					.32	
Color: Name	020		.79				
Color: Ident	021		.80				
Resp Verb Dir	022			.67			
Attn to Tasks	023			-.65			
Percent of Total Variance		16	8	6	6	2	2

N = 1058

Note: Factor loadings of less than .30 have been omitted from this table.

The first factor, a general mathematics factor, accounts for a considerably higher percent of the total variance (16%) than any of the other factors. All scales in the K-01 battery have loadings higher than .30 on this factor except the geometry scales (001, 002, and 003), the scales dealing with color (019, 020, 021), the visual memory scales (008, 017), and the two ratings by the testers (022, 023). The highest loadings on this factor occur for those scales most directly related to knowledge of numbers and counting, e.g., Counting Buttons (004), Writing Numerals (005), Identifying Numerals (007), Ordinal Number (013), and Rote Counting (016). A somewhat lower loading was obtained for Counting Members of a Given Set - Picture Cards (006), a scale that requires counting pictures arranged irregularly on cards.

The remaining factors are rather specific ones and are marked by a very small number of variables. The second factor has loadings only for two color scales, Color - Naming (020) and Color - Identifying (021); these two scales appear on no other factor. Test-taking behavior is measured in factor 3. Factor 4, a geometry factor, has the highest loadings for Geometric Shapes - Naming (002) and Geometric Shapes - Identifying (003), and very low loadings for Vocabulary (010) and Classifying (015). (The latter two scales have some items using geometric shapes.) The remaining two factors, a matching factor (factor 5) and a visual memory factor (factor 7), accounted for only a small percent of the variance; and very low loadings occurred for the variables on these factors.

Factor analysis of scales from K-01 together with scales from WPPSI and MRT. Means and standard deviations obtained for variables included in the factor analysis of the scales of K-01 with those from WPPSI and MRT are shown in Table 4.2A, and factor loadings are given in Table 4.2B. (The correlation matrix is in Table A4.2 in Appendix 4.

All the principal factors found previously in Table 4.1B appear again in Table 4.2B, and the variables have similar loadings on factors in the two analyses. Again, a general mathematics factor appears (factor 5) which corresponds to factor 1 in the previous analysis. The total percent of variance accounted for by this factor is not as high, however, as was the general mathematics factor obtained when the scales from K-01 were factor analyzed separately. The pattern of factor loadings on factor 5 is very similar to that obtained for factor 1 for the previous analysis, but the loadings tend to be slightly lower on factor 5. Two variables, Equivalent Sets - Dots (012) and Ordering Geometric Shapes (014), do not appear on the general mathematics factor in Table 4.2B although they did appear on the comparable factor (factor 1) in Table 4.1B. None of the scales from the WPPSI appear on factor 5, but three scales from the MRT appear here. The scale from the MRT having the highest loading is Numbers (R205),

Table 4.2A

Means and Standard Deviations for Scales Used in Factor Analysis of Beginning-of-Kindergarten, WPPSI and MRT Scales
Total Sample

Scales		Item N	MN	SD
K-01 Scales				
Geom Shape: Match	001	4	3.83	0.57
Geom Shape: Name	002	4	1.52	1.16
Geom Shape: Ident	003	4	2.52	1.22
Count Buttons	004	7	4.44	2.55
Write Numerals	005	7	0.99	1.87
Count Set: PC	006	8	4.12	2.92
Ident Numbers	007	8	4.43	3.01
Vis Memory: Obj	008	5	3.29	1.27
Vocabulary	010	20	14.91	2.96
Equiv Sets: Dots	012	6	3.17	2.13
Ordinal No.	013	8	3.57	1.77
Order Geom Shapes	014	2	0.83	0.86
Classify	015	9	4.37	1.96
Rote Counting	016	1	1.53	1.59
Vis Memory: Pict	017	4	1.11	1.03
Color: Match	019	6	5.90	0.47
Color: Name	020	7	5.94	1.73
Color: Ident	021	6	5.28	1.50
Resp Verb Dir	022	1*	3.65	0.57
Attn to Tasks	023	1**	1.60	0.91
WPPSI Scales				
WPPSI Vocabulary	M112	22***	9.95	2.92
WPPSI Similarities	M114	16***	10.36	2.78
WPPSI Pict Compl	M117	23***	9.89	2.73
WPPSI Block Design	M120	10***	10.63	2.62
MRT Scales				
MRT Word Meaning	R201	16	9.32	3.00
MRT Listening	R202	16	10.74	2.58
MRT Matching	R203	14	9.01	3.32
MRT Alphabet	R204	16	12.12	3.86
MRT Numbers	R205	26	13.11	4.07
MRT Copying	R206	14	5.42	2.51

N = 600

*Test behavior scored on a 4-point scale, with 4 as high.
**Test behavior scored on a 4-point scale, with 1 as high.
***WPPSI means and standard deviations are from scaled scores with a range of 1 to 19.

Table 4.2B

Factor Loadings for Beginning-of-Kindergarten, WPPSI and MRT Scales
Total Sample

Scales		Factors 1	2	3	4	5	7
K-01 Scales							
Geom Shape: Match	001						
Geom Shape: Name	002						.60
Geom Shape: Ident	003						.57
Count Buttons	004	.30	.30			.57	
Write Numerals	005					.53	
Count Set: PC	006	.30				.42	
Ident Numbers	007					.63	
Vis Memory: Obj	008						
Vocabulary	010			.35		.33	
Equiv Sets: Dots	012	.37			.30		
Ordinal No.	013					.50	
Order Geom Shapes	014	.32					
Classify	015					.34	.35
Rote Counting	016					.59	
Vis Memory: Pict	017						
Color: Match	019						
Color: Name	020		.78				
Color: Ident	021		.78				
Resp Verb Dir	022				.69		
Attn to Tasks	023				-.66		
WPPSI Scales							
WPPSI Vocabulary	M112			.63			
WPPSI Similarities	M114			.51			
WPPSI Pict Compl	M117	.50					
WPPSI Block Design	M120	.62					
MRT Scales							
MRT Word Meaning	R201	.36		.47			
MRT Listening	R202	.38		.47			
MRT Matching	R203	.55					
MRT Alphabet	R204	.33				.39	
MRT Numbers	R205	.47		.31		.47	
MRT Copying	R206	.56				.32	
Percent of Total Variance		9	6	6	4	10	4

N = 600

Note: Factor loadings of less than .30 have been omitted from this table.

and those scales having low loadings are Alphabet (R204) and Copying (R206). The appearance of Alphabet on this factor can be attributed to the relationship between the ability to recognize letters of the alphabet and the ability to identify numerals. Identifying Numerals (007) which had the highest loading on factor 5 has a correlation of $r = .51$ with Alphabet (R204).

Again, factors appear for color (factor 2), behavior during testing (factor 4), and geometry (factor 7). These three factors correspond to factors 2, 3, and 4, respectively, in the previous analysis. The two factors in the first analysis that were characterized by extremely low loadings did not appear in the present analysis.

The two new factors (1 and 3) which were obtained in the present analysis had scales from the WPPSI and the MRT as the principal markers. Factor 1, characterized by ability in performance of tasks, includes the two performance scales from WPPSI: Picture Completion (M117) and Block Design (M120). All the MRT scales are also found on this factor, with the highest loadings obtained by two performance scales, Copying (R206) and Matching (R203), and a moderately high loading for Numbers (R205). Factor 3 is a factor measuring verbal ability and includes the two verbal scales from the WPPSI, Vocabulary (M112) and Similarities (M114), and the two scales from MRT measuring word knowledge, Word Meaning (R201) and Listening (R202). The ELMA scale measuring knowledge of vocabulary related to mathematics (010) has a loading on factor 3, although the loading is low.

As noted in the discussion above, there were some minor differences between the factor analysis on K-01 scales alone and the factor analysis on K-01 scales together with WPPSI and MRT scales. These differences could result either from the difference in the total set of variables used in the two analyses or from differences in correlations obtained for variables in the two analyses. The sample size for the correlation matrix in the second analysis was considerably smaller than that used in the first analysis since the inclusion of the MRT eliminated all students who dropped out of the study between the end of kindergarten and the beginning of first grade. Inspection of the correlation matrices in Tables A4.1 and A4.2 of Appendix 4 shows quite a few changes in correlations caused by the change in sample size used in the two analyses.

<u>Factor Analyses of End-of-Kindergarten Scales</u>

A factor analysis was performed for the common scales of K-02, i.e., those given to the total population, together with the WPPSI and MRT scales. In addition, factor analyses were performed for the scales common to the four subpopulations to evaluate the results obtained for those scales given to

approximately one-fourth of the sample. Further, the scales from K-02 given only to subpopulations were factor analyzed together with the common K-02 scales and the scales of the WPPSI and the MRT in each subpopulation.

Factor analysis of end-of-kindergarten common scales in the total population. The means and standard deviations obtained for the common end-of-kindergarten scales in the total population are given in Table 4.3A. As can be seen from this table, the average scores obtained on all the scales of K-02, except Counting Members of a Given Set - Picture Cards (110), are less than one standard deviation from the maximum possible score. Although the scales from K-01 had been extended for K-02 so as to include more difficult items, the scores on K-02 scales are restricted much more at the high end of the range than had been the case for the K-01 scores. The values of Cronbach's alpha for the K-02 common scales were all at least .60 .

Factor loadings obtained in the factor analysis of common K-02 scales are shown in Table 4.3B, and the correlation matrix is given in Table A4.3 in Appendix 4. The second factor obtained in the analysis was a general mathematics factor. The highest loadings on factor 2 were obtained for the two scales requiring counting of sets (110 and 111), and slightly lower loadings were obtained for the two scales requiring formation of equivalent sets (118 and 119). Numbers (R205) from the MRT also had a low loading on factor 2.

Factor 1, a performance factor, has as the variables with highest loadings, the K-02 scale Ordering Composite (147), two WPPSI scales, Picture Completion (M117) and Block Design (M120), and MRT scales Copying (R206), Matching (R203), and Numbers (R205). Low loadings on factor 1 were obtained by Classifying S-2 (130) and the MRT scales Word Meaning (R201), Listening (R202), and Alphabet (R204).

On the remaining factors, no high loadings are found for any K-02 scale. Factor 7 is a verbal ability factor with the highest loadings occurring for the two WPPSI verbal scales, Vocabulary (M112) and Similarities (M114), and the two MRT scales measuring vocabulary, Word Meaning (R201) and Listening (R202). Low loadings were obtained on factor 7 by the K-02 scales Classifying S-2 (130) and Ordering Composite (147). Factor 5 appears to be a factor specific to performance on the readiness test. Test-taking behavior appears in factor 3, separate from performance, as it was in the factor analyses of the beginning-of-kindergarten scales.

The remaining two factors, 4 and 6, account for a very small percent of the total variance. Geometric Shapes - Identifying (104) and Alphabet (R204) appear together on factor 4; the scales Equivalent Sets - Objects (118) and Equivalent Sets - Dots (119) are found on factor 6.

Table 4.3A

Means and Standard Deviations for Scales Used in Factor Analysis of End-of-Kindergarten Common Scales
Total Sample

Scales		Item N	MN	SD
K-02 Common Scales				
Geom Shape: Ident	104	5	4.50	0.88
Count Set: PC	110	10	5.60	2.86
Count Set: Obj	111	10	7.49	2.63
Equiv Sets: Obj	118	6	4.39	1.91
Equiv Sets: Dots	119	6	4.85	1.52
Classify S-2	130	6	5.34	1.18
Resp Verb Dir	143	1*	3.82	0.44
Attn to Tasks	144	1**	1.32	0.74
Order Comp	147	9	5.82	3.72
WPPSI Scales				
WPPSI Vocabulary	M112	22***	9.85	2.94
WPPSI Similarities	M114	16***	10.23	2.82
WPPSI Pict Compl	M117	23***	9.85	2.73
WPPSI Block Design	M120	10***	10.59	2.66
MRT Scales				
MRT Word Meaning	R201	16	9.24	3.02
MRT Listening	R202	16	10.58	2.70
MRT Matching	R203	14	8.96	3.42
MRT Alphabet	R204	16	11.96	3.96
MRT Numbers	R205	26	12.96	4.18
MRT Copying	R206	14	5.38	2.56

N = 671

*Test behavior scored on a 4-point scale, with 4 as high.

**Test behavior scored on a 4-point scale, with 1 as high.

***WPPSI means and standard deviations are from scaled scores with a range of 1 to 19.

Table 4.3B

Factor Loadings for End-of-Kindergarten Common Scales
Total Sample

Scales		Factors 1	2	3	4	5	6	7
K-02 Common Scales								
Geom Shape: Ident	104				.34			
Count Set: PC	110		.66					
Count Set: Obj	111		.70					
Equiv Sets: Obj	118		.58				.33	
Equiv Sets: Dots	119		.59				.33	
Classify S-2	130	.33						.33
Resp Verb Dir	143			.72				
Attn to Tasks	144			-.72				
Order Comp	147	.50						.30
WPPSI Scales								
WPPSI Vocabulary	M112							.63
WPPSI Similarities	M114							.50
WPPSI Pict Compl	M117	.51						.30
WPPSI Block Design	M120	.58						
MRT Scales								
MRT Word Meaning	R201	.32						.56
MRT Listening	R202	.30				.30		.54
MRT Matching	R203	.45				.37		
MRT Alphabet	R204	.30			.33	.37		
MRT Numbers	R205	.44	.37			.41		.38
MRT Copying	R206	.55						
Percent of Total Variance		12	12	7	2	4	1	10

N = 671

Note: Factor loadings of less than .30 have been omitted from this table.

Factor analysis of common K-02 scales in subpopulations. The common K-02 scales were factor analyzed separately for each of the subpopulations W, X, Y, and Z to determine whether the factor pattern obtained in the total sample would be maintained in the smaller subsamples. The results are presented in Tables A4.4 through A4.8 in Appendix 4. The factor patterns were basically the same in the subpopulations as they had been in the total sample except in the Z-population. In the latter, Counting Members of a Given Set - Picture Cards (110) and Objects (111) appear on a separate factor from Equivalent Sets - Objects (118) and Dots (119). Also, the factor marked by the WPPSI performance scales, M117 and M120, and Ordering Composite (147), which had been found for the total population, failed to appear in the Z-population. Results obtained in the factor analysis of the scales given only to the Z-population, to be discussed subsequently, must be considered tentative since the factor pattern for the common K-02 scales for this population differed from the other subpopulations. There was also some inconsistency in the pattern of loadings for the scales from the MRT in the four subpopulations.

Factor analyses of subpopulation scales in K-02. Factor analyses were performed for the subpopulation scales in K-02 together with the common scales in K-02 and the scales from MRT and WPPSI. The means and standard deviations for the scales given only to a part of the total sample are shown in Table 4.4. Statistics for the common scales in subpopulations are shown in Table A4.4 of Appendix 4, and are quite close to those obtained for the total sample shown in Table 4.3A. The results of the factor analyses are shown in Table 4.5 (W-population), Table 4.6 (X-population), 4.7 (Y-population) and 4.8 (Z-population). The correlation matrices obtained in conjunction with these factor analyses are presented in Tables A4.9 through A4.12 of Appendix 4.

The three scales in K-02 given only to W-population measured visual memory. The values obtained for Cronbach's alpha for these three scales were quite low ($.26 \leq \alpha \leq .34$). Two of these scales, Visual Memory - Picture Cards (133W) and Visual Memory - Shapes (135W), appear by themselves on factor 4, as seen in Table 4.5; while Visual Memory - Objects (114W) does not have loadings on any factor that are high enough to be included in the table.

The four X-population scales had satisfactory values for Cronbach's alpha ($\alpha \geq .60$); but the average scores for these scales, except Writing Numerals (108X), were close to the maximum possible value, as can be seen in Table 4.4. Counting Buttons (106X) and Identifying Numerals (113X), the average value was less than one standard deviation from the maximum score. In the factor analyses for the X-population, presented in Table 4.6, three of the X-population scales, Counting Buttons, Writing Numerals, and Identifying Numerals, appeared together on factor

Table 4.4

Means and Standard Deviations for Scales Used in Factor Analyses of End-of-Kindergarten Subpopulation Scales

Scales		Item N	MN	SD
W-Population Scales (N = 163)				
Vis Memory: Obj	114W	5	3.53	1.15
Vis Memory: PC	133W	4	1.56	1.10
Vis Memory: Shapes	135W	4	2.45	0.98
X-Population Scales (N = 180)				
Count Buttons	106X	9	7.83	1.97
Write Numerals	108X	9	4.72	2.95
Ident Numerals	113X	10	8.73	2.28
Vocabulary	117X	19	15.36	2.99
Y-Population Scales (N = 162)				
Geom Shape: Name	102Y	5	4.20	1.05
Ordinal Number	120Y	8	5.57	1.95
Classify S-1	128Y	9	6.23	1.67
Z-Population Scales (N = 164)				
Vis Memory: Pict	131Z	4	1.34	0.95
Order Sets: Obj	137Z	3	1.66	1.29
Order Sets: PC	139Z	3	1.77	1.28
Conservation	146Z	6	8.62	2.93

Table 4.5

Factor Loadings for End-of-Kindergarten Scales for the W-Population

Scales		Factors 1	2	3	4	5	6	7	8
K-02 W-Population Scales									
Vis Memory: Obj	114W								
Vis Memory: PC	133W				.51				
Vis Memory: Shapes	135W				.48				
K-02 Common Scales									
Geom Shape: Ident	104								.36
Count Set: PC	110			.64					
Count Set: Obj	111			.69					
Equiv Sets: Obj	118			.60					.32
Equiv Sets: Dots	119			.63					.35
Classify S-2	130						.45		
Resp Verb Dir	143		.76						
Attn to Tasks	144		-.74						
Order Comp	147	.46		.30			.45		
WPPSI Scales									
WPPSI Vocabulary	M112					.61			
WPPSI Similarities	M114					.58			
WPPSI Pict Compl	M117	.55							
WPPSI Block Design	M120	.67							
MRT Scales									
MRT Word Meaning	R201	.31				.35	.57		
MRT Listening	R202					.32	.47		
MRT Matching	R203	.42		.38					
MRT Alphabet	R204	.32		.39					.38
MRT Numbers	R205	.49		.47					
MRT Copying	R206	.58		.42					
Percent of Total Variance		10	6	12	3	6	6	2	4

N = 163

Note: Factor loadings of less than .30 have been omitted from this table.

Table 4.6

Factor Loadings for End-of-Kindergarten Scales for the X-Population

Scales		Factors 1	2	3	4	5
K-02 X-Population Scales						
Count Buttons	106X		.43		.53	
Write Numerals	108X				.63	
Ident Numerals	113X				.71	
Vocabulary	117X					.62
K-02 Common Scales						
Geom Shape: Ident	104					
Count Set: PC	110		.71			
Count Set: Obj	111		.72			
Equiv Sets: Obj	118	.32	.61			
Equiv Sets: Dots	119	.32	.53			
Classify S-2	130	.30				.48
Resp Verb Dir	143			.72		
Attn to Tasks	144			-.73		
Order Comp	147	.49				.36
WPPSI Scales						
WPPSI Vocabulary	M112	.31				.59
WPPSI Similarities	M114					.36
WPPSI Pict Compl	M117	.60				
WPPSI Block Design	M120	.61				
MRT Scales						
MRT Word Meaning	R201					.72
MRT Listening	R202					.61
MRT Matching	R203	.37	.30		.32	.32
MRT Alphabet	R204				.60	.34
MRT Numbers	R205	.34	.31		.47	.49
MRT Copying	R206	.50	.32		.36	
Percent of Total Variance		9	11	6	11	13

N = 180

Note: Factor loadings of less than .30 have been omitted from this table.

Table 4.7

Factor Loadings for End-of-Kindergarten Scales for the Y-Population

Scales		Factors 1	2	3	4	5	6
K-02 Y-Population Scales							
Geom Shape: Name	102Y						.63
Ordinal Number	120Y	.55		.41			
Classify S-1	128Y		.35				.46
K-02 Common Scales							
Geom Shape: Ident	104						.65
Count Set: PC	110			.63			
Count Set: Obj	111			.72			
Equiv Sets: Obj	118			.62			
Equiv Sets: Dots	119			.68			
Classify S-2	130	.31	.50				.30
Resp Verb Dir	143				.71		
Attn to Tasks	144				-.70		
Order Comp	147	.61					
WPPSI Scales							
WPPSI Vocabulary	M112					.62	
WPPSI Similarities	M114					.53	
WPPSI Pict Compl	M117	.33					
WPPSI Block Design	M120	.48		.37			
MRT Scales							
MRT Word Meaning	R201	.51				.38	
MRT Listening	R202	.57				.41	
MRT Matching	R203	.48		.38			
MRT Alphabet	R204	.34		.33			.41
MRT Numbers	R205	.66		.37			
MRT Copying	R206	.58		.30			
Percent of Total Variance		15	3	13	6	6	8

N = 162

Note: Factor loadings of less than .30 have been omitted from this table.

Table 4.8

Factor Loadings for End-of-Kindergarten Scales for the Z-Population

Scales		Factors 1	2	3	4	5	6	7	8
K-02 Z-Population Scales									
Vis Memory: Pict	131Z				.31				
Order Sets: Obj	137Z			.78					
Order Sets: PC	139Z			.80					
Conservation	146Z		.31	.39				.31	
K-02 Common Scales									
Geom Shape: Ident	104								
Count Set: PC	110		.69						
Count Set: Obj	111		.68						
Equiv Sets: Obj	118						.67		
Equiv Sets: Dots	119						.68		
Classify S-2	130							.32	
Resp Verb Dir	143				.73				
Attn to Tasks	144				-.74				
Order Comp	147			.59					
WPPSI Scales									
WPPSI Vocabulary	M112					.65			
WPPSI Similarities	M114					.51			
WPPSI Pict Compl	M117					.49		.36	
WPPSI Block Design	M120							.54	
MRT Scales									
MRT Word Meaning	R201					.44		.35	
MRT Listening	R202					.57		.46	
MRT Matching	R203								.46
MRT Alphabet	R204								.64
MRT Numbers	R205			.34		.38		.59	.42
MRT Copying	R206								
Percent of Total Variance		1	6	10	7	9	6	7	5

N = 164

Note: Factor loadings of less than .30 have been omitted from this table.

4 with two scales from the MRT, Alphabet (R204) and Numbers (R205). The MRT scales Matching (R203) and Copying (R206) had low loadings on this factor. Counting Buttons also appeared on factor 2, the factor in the X-population which corresponds to the general mathematics factor found for the common scales in the total population (see factor 2 in Table 4.3B). The K-02 scale Vocabulary (117X) appeared on factor 5, a vocabulary factor that corresponds to factor 7 in Table 4.3B. The two scales from the MRT measuring knowledge of vocabulary, Word Meaning (R201) and Listening (R202), and Vocabulary (M112) from WPPSI also had high loadings on factor 5. Somewhat lower loadings were found for Numbers (R205) of the MRT and Classifying S-2 (130) from K-02.

One of the three Y-population scales, Geometric Shapes - Naming (102Y), had a mean less than one standard deviation from the maximum score (refer to Table 4.4). The values for Cronbach's alpha fell slightly below .60 for Geometric Shapes - Naming ($\alpha = .53$) and Classifying S-1 ($\alpha = .51$). As shown in Table 4.7, Ordinal Number (120Y) appeared on factor 1 together with the common K-02 scale Ordering Composite (147). The highest loading on factor 1 was obtained by Numbers (R205) with the remaining scales of the MRT having somewhat lower loadings. Block Design (M120) of WPPSI also appeared on this factor. Factor 1 on this analysis corresponds fairly closely to factor 1 in Table 4.3B.

Ordinal Number also appeared on factor 3, the general mathematics factor in the factor analysis of the Y-population scales which corresponds to factor 2 in the factor analysis of the common scales in the total population. The two geometry scales, Geometric Shapes - Identifying (104) and Geometric Shapes - Naming (102Y), appeared on factor 6 together with the Classifying scales (128Y and 130) and with Alphabet (R204). The two Classifying scales also appeared by themselves on factor 2.

The scales Ordering Sets - Objects (137Z) and Ordering Pictured Sets (139Z), together with Ordering Composite (147), appeared on factor 3 in the factor analysis of scales in the Z-population, presented in Table 4.8. (Scales 137Z and 139Z required ordering by number, while Scale 147 required ordering by size.) Conservation (146Z) and Numbers (R205) had low loadings on this ordering factor (3). The other loadings for the Z-population scales on factors in Table 4.8 were very low. Cronbach's alpha was only .04 for Visual Memory - Pictures (131Z), but the other three Z-population scales had values greater than .60. All results obtained in the factor analysis of the Z-population may, however, only apply to this particular sample since the factor analysis for the common scales in the Z-population (see Table A4.8 in Appendix 4 differed from factor analyses of common scales in other subpopulations. In factor analyses for

the W, X, and Y-populations, Ordering Composite (147) had appeared on a factor with the WPPSI performance scales, but this factor was not found in the Z-population. (The correlations between Ordering Composite and the WPPSI performance scales are lower in the Z-population than in the other populations.)

3. Summary of Recurring Factor Patterns for Factor Analyses of Kindergarten Scales

The mathematics scales dealing with number tend to appear on a single factor in the factor analyses of both the K-01 scales and the K-02 scales. Thus, the scales based on tasks requiring counting, formation of equivalent sets, and use of ordinal number appear on a general mathematics factor. The scales involving geometric concepts, classifying, ordering by size, and knowledge of mathematics vocabulary are not found with this factor.

The Numbers scale from the MRT appeared on the general mathematics factor, but the WPPSI scales did not appear on this factor. The principal difference found in the pattern of loadings in the K-01 and K-02 factor analyses was that writing and identifying numbers had high loadings on the general mathematics factor when the K-01 scales were factor analyzed, but appeared on a different factor in the factor analysis of the K-02 scales.

No high loadings on any mathematics factors were found for any of the scales of the WPPSI in the factor analysis of the scales of K-01; in the K-02 factor analyses, however, the performance scales of the WPPSI were associated with the scale in the K-02 battery requiring ordering by size. The Numbers scale of the MRT was associated with the performance scales of the WPPSI in both the K-01 and the K-02 factor analyses, but Matching and Copying of the MRT had equally high or higher loadings on this performance intelligence factor.

Chapter 5

FACTOR ANALYSES BY YEAR, OF FIRST, SECOND, AND THIRD GRADE SCALES

Mathematics test batteries were administered at the end of first, second, and third grades. The areas covered in the tests were number comparison - order, place value, number line, application (word problems), rationals, computation, comprehension of basic properties of arithmetic, and geometry. The scales used each successive year to measure these areas were very similar except for scales of geometry and comprehension. At the end of first and second grades, a few additional scales covered areas that had been measured previously in kindergarten. Also, at the end of each year from first to third grades, measures of reading were obtained from Word Reading and Paragraph Meaning of the Stanford Achievement Test (SAT).

A number of tests of intelligence were administered at different times during first and second grade. These tests were the Raven Progressive Matrices Test, given in the second half of first grade, the Kuhlmann-Anderson (K-A) Test, given at the beginning of second grade, and the WISC given in the second half of the second grade year. Since the K-A test was given near the beginning of second grade, it is included with the end-of-first-grade scales in all factor analyses.

The method of factor analysis used was the same as that described in the previous chapter for the kindergarten factor analyses. Orthogonal factors were obtained, and rotation to simple structure was performed with the Varimax method of rotation.

1. First Grade Scales

Description of Mathematics Scales

The batteries of mathematics tests given at the end of first grade (Forms 1-02, 1-03, 1-04 and 1-05) were group-administered except for one of two scales measuring comprehension.[52]

Place Value (306) was designed to measure the pupil's ability to interpret the meaning of symbols in the numeration system. The items were of three

[52] A complete description of the tests and scale properties can be found in ELMA Technical Report No. 2.

general types: identification of digits in the ones or tens place; identification of a numeral in terms of its numerical description; interpretation of a numeral in terms of a pictorial display and vice versa. The scale consisted of multiple choice items and items requiring constructed responses. The child's understanding of numerical order was assessed in Number Comparison - Order (307). The child was required to identify numerals or sets of dots which best illustrated the fundamental concepts of "largest," "fewer than," "between," "more than," "greatest," and "least."

Number Line (308) was designed to test the pupil's ability to interpret a numerical system in terms of a geometric concept. Some items, requiring constructed responses, dealt with numerical order and the idea of correspondence; while the other items were in multiple choice format and required a translation of addition in terms of actions performed on the number line. The scale Applications (309) was composed of story problems that were designed to measure the child's ability to select and perform the relevant arithmetic operations. Six of the Applications' items involve either addition or subtraction, while the seventh deals with partitioning a set into two equivalent groups.

The task required of the child in most of the items of the Rationals (310) scale was to mark the fraction that indicated which proportion of a figure was shaded. For one item, the child was to construct a set associated with a given fraction. The computation scales were devised to test the child's ability to add, subtract, and multiply. Most of the problems were in sentence format. Three computation scales were obtained: Computation - Addition (311), Computation - Subtraction (312), and Computation - Multiplication (313).

Comprehension of basic mathematical concepts was measured by two scales at the end of first grade, one administered to groups of children, Comprehension - Group (328), and one to children individually, Comprehension - Individual (329). For two of the items of the group scale, the child was to choose the pictures, consisting of a set of dots, which illustrated subtraction in terms of set partitioning and multiplication in terms of arrays. One item was a word problem to be solved by using the commutative property of addition; the last item, a word problem, required knowledge of the concept of fourths. Comprehension - Individual (329) measured the child's understanding of the fundamental properties of addition and subtraction by manipulation of concrete objects to interpret mathematical sentences and vice versa.

The geometry scales were based on tasks requiring the identification of geometric shapes. For Identifying Triangles (321), the child had to mark triangular figures that were scattered among other geometric shapes on a page of the test booklet; for Identifying Rectangles (322), he had to locate and mark

the rectangles on a separate page of the test booklet. For the third geometry scale, Curved Figures (323), the child was given one point whenever he did not mark a figure that resembled a triangle or rectangle except that it had some curved sides.

For most of the scales, values of Cronbach's alpha were at least .60, but there were some exceptions. The values for Cronbach's alpha fell in the range .54 - .59 for Number Comparison - Order (307), Number Line (308), and Applications (309). A very low value of $\alpha = .15$ was obtained for Rationals (310) and for Comprehension - Group (328), $\alpha = .33$.

Description of Intelligence Scales

The Kuhlmann-Anderson Test contains eight subtests. Three of the eight subtests deal with mathematical content, i.e., vocabulary, counting, and word problems. The intelligence quotient is obtained from the total of the scores for the eight subtests and the child's chronological age at the time of testing. The scale labelled IQ: Kuhlmann-Anderson (M324), used in the factor analyses, is the intelligence quotient thus obtained.

The Raven Coloured Progressive Matrices Test requires the ability to perceive relationships of a missing portion of a pattern to the whole. The three scales from this test are based on the three sets of progressively more difficult patterns presented the child. Raven Set A (M201) is the scale based on twelve patterns in which the child must complete a simple continuous pattern, or complete a pattern showing progressive changes in one and in two directions. Raven Set Ab (M202) is the scale based on twelve patterns more difficult than Set A. The child must complete a set of discrete figures that form a repetitive pattern and complete a set of discrete figures in which three are related as a whole to be completed by a fourth figure. Raven Set B (M203) also is based on twelve items and requires the child to complete a repetitive pattern as in Set Ab, but further contains items in which reasoning must be used to form a pattern of analogous changes.

Factor Analyses

Factor analyses were performed on mathematics tests, intelligence tests, and a reading test given at the end of first grade. The mathematics tests and the reading test (SAT) were given near the end of the first grade. The Raven and the K-A tests, the two intelligence tests included in the factor analyses, were given in the second half of first grade and the beginning of second grade, respectively. As stated previously, the K-A is included with the end-of-first-grade tests since it was given near the beginning of the second grade year.

Since somewhat different samples received the various tests, three factor analyses were performed to check the stability of the pattern of factor loadings in the different samples. One factor analysis included all the tests mentioned above, and, therefore, used only the original sample since the Raven test had been administered only to this group. A second analysis eliminated the Raven test so that a factor structure for the tests could be obtained for the total sample, i.e., the original students and the students added at the end of first grade. The same analysis with the Raven test excluded was repeated for the original sample to check on stability of patterns between the original sample and the total sample.

Results of factor analysis with all tests included (original sample). The results of the factor analysis that included all the tests administered are given in Table 5.1A (means and standard deviations), Table 5.1B (factor loadings), and Table A5.1 in Appendix 5 (correlation matrix).

Factor 5, a general mathematics factor which accounts for the highest proportion of the variance, includes all the mathematics scales except Rationals (310) and the geometry scales (321, 322, and 323). The two reading scales (A201 and A205) and [illegible] of the intelligence scales, IQ: Kuhlmann-Anderson (M324), also had low loadings on factor 5. The highest loadings on this factor were obtained by Computation - Addition (311) and Computation - Subtraction (312), and the next highest loadings were found for Place Value (306) and Application (309). The remaining mathematics scales had loadings that were slightly lower and were all of about the same magnitude.

Factor 1, which is primarily a reading factor, is marked by high loadings for the two SAT scales, Word Reading (A201) and Paragraph Meaning (A205), and a low loading for IQ: Kuhlmann-Anderson (M324). Factor 3 is principally a factor specific to the Raven Test. IQ: Kuhlmann-Anderson (M324) has a low loading on factor 3, and three mathematics scales have very low loadings on this factor. Factor 4 is a test-taking behavior factor. Factor 6 cannot be adequately described because of the low values of both scales having loadings on it.

Factor analysis of all tests except the Raven (total sample). Results for the analysis with the total sample and with the Raven excluded are given in Table 5.2A (means and standard deviations), Table 5.2B (factor loadings), and Table A5.2 in Appendix 5 (the correlation matrix). The factor strucure is very similar to that found for the original sample and including the Raven. There are changes, however, for some variables on the general mathematics factor, i.e., factor 1 in Table 5.2B and factor 5 in Table 5.1B, which account for the highest proportion of variance.

Table 5.1A

Means and Standard Deviations for Scales Used in Factor Analysis
of End-of-First-Grade Scales
Original Students Only

Scales		Item N	MN	SD
Math Scales				
Place Value	306	8	4.41	2.05
No. Compare	307	7	5.19	1.50
No. Line	308	5	3.27	1.30
Application	309	7	4.15	1.68
Rationals	310	7	2.89	1.33
Compute-Add	311	10	7.05	2.27
Compute-Subtract	312	10	4.85	3.14
Compute-Multiply	313	2	0.36	0.69
Resp Verb Dir	317	1*	3.92	0.26
Attn to Tasks	318	1**	1.26	0.54
Ident Triangles	321	6	4.68	1.86
Ident Rectangles	322	4	2.70	1.42
Curved Figures	323	5	3.42	1.47
Comprehend-Gp	328	4	1.75	1.07
Comprehend-Ind	329	4	2.29	1.27
SAT Scales				
SAT Word #Rt	A201	35	20.51	7.69
SAT Paragraph #Rt	A205	38	20.12	9.52
Raven Scales				
Raven Set A	M201	12	7.51	1.49
Raven Set Ab	M202	12	5.09	2.10
Raven Set B	M203	12	4.02	1.76
Kulhmann-Anderson				
IQ: Kuhl-Ander	M324	***	108.89	14.80

N = 532

*Test behavior scored on a 4-point scale, with 4 as high.

**Test behavior scored on a 4-point scale, with 1 as high.

***Kuhlmann-Anderson IQ is 67-180 for C.A. of 7-0 to 7-9.

Table 5.1B

Factor Loadings for End-of-First-Grade Scales
Original Students Only

Scales		Factors 1	2	3	4	5	6
Math Scales							
Place Value	306			.30		.59	
No. Compare	307					.44	
No. Line	308			.31		.38	
Application	309			.31		.59	
Rationals	310						
Compute-Add	311					.67	
Compute-Subtract	312					.69	
Compute-Multiply	313					.41	.32
Resp Verb Dir	317				.59		
Attn to Tasks	318				-.60		
Ident Triangles	321		.64				
Ident Rectangles	322		.59				
Curved Figures	323		-.57				
Comprehend-Gp	328					.42	.39
Comprehend-Ind	329				.36	.45	
SAT Scales							
SAT Word #Rt	A201	.76				.37	
SAT Paragraph #Rt	A205	.76				.39	
Raven Scales							
Raven Set A	M201			.54			
Raven Set Ab	M202			.70			
Raven Set B	M203			.62			
Kuhlmann-Anderson							
IQ: Kuhl-Ander	M324	.36		.39		.41	
Percent of Total Variance		8	6	9	5	15	2

N = 532

Note: Factor loadings of less than .30 have been omitted from this table.

Table 5.2A

Means and Standard Deviations for Scales Used in Factor Analysis of End-of-First-Grade Scales Excluding the Raven Scales Total Sample

Scales		Item N	MN	SD
Math Scales				
Place Value	306	8	4.28	2.03
No. Compare	307	7	5.10	1.52
No. Line	308	5	3.14	1.32
Application	309	7	4.04	1.69
Rationals	310	7	2.84	1.34
Compute-Add	311	10	6.83	2.41
Compute-Subtract	312	10	4.63	3.13
Compute-Multiply	313	2	0.30	0.65
Resp Verb Dir	317	1*	3.92	0.28
Attn to Tasks	318	1**	1.24	0.54
Ident Triangles	321	6	4.55	1.88
Ident Rectangles	322	4	2.48	1.51
Curved Figures	323	5	3.47	1.44
Comprehend-Gp	328	4	1.70	1.08
Comprehend-Ind	329	4	2.19	1.26
SAT Scales				
SAT Word #Rt	A201	35	19.91	7.57
SAT Paragraph #Rt	A205	38	19.08	9.40
Kuhlmann-Anderson				
IQ: Kuhl-Ander	M324	***	107.58	14.56

N = 964

*Test behavior scored on a 4-point scale, with 4 as high.

**Test behavior scored on a 4-point scale, with 1 as high.

***Kuhlmann-Anderson IQ is 67-180 for C.A. of 7-0 to 7-9.

Table 5.2B

Factor Loadings for End-of-First-Grade Scales Excluding the Raven Scales
Total Sample

Scales		Factors 1	2	3	4	5
Math Scales						
Place Value	306	.65				
No. Compare	307	.57				
No. Line	308	.52				
Application	309	.62				
Rationals	310					
Compute-Add	311	.69				
Compute-Subtract	312	.71				
Compute-Multiply	313	.36				.30
Resp Verb Dir	317			.66		
Attn to Tasks	318			-.67		
Ident Triangles	321		.61			
Ident Rectangles	322		.59			
Curved Figures	323		-.62			
Comprehend-Gp	328	.40				.35
Comprehend-Ind	329	.52				
SAT Scales						
SAT Word #Rt	A201	.43			.75	
SAT Paragraph #Rt	A205	.42			.75	
Kuhlmann-Anderson						
IQ: Kuhl-Ander	M324	.57			.31	
Percent of Total Variance		21	7	6	9	2

N = 964

Note: Factor loadings of less than .30 have been omitted from this table.

The four scales having the highest loadings on factor 1 in Table 5.2B are the same as those found in the previous analysis for the original sample. These scales were Computation - Addition and Subtraction, Place Value, and Application. The largest differences in loadings on the general mathematics factor between the two analyses occurred for IQ: Kuhlmann-Anderson, Number Comparison, and Number Line, all of which have higher loadings in the analysis done with the Raven excluded. As a result, a higher proportion of variance was accounted for by this general mathematics factor in the present analysis. The remaining factors are very similar in the two analyses.

Factor analysis with Raven omitted (original sample). The factor analysis of all the variables except the Raven scales was repeated for the original sample (see Tables A5.3 through A5.5 in Appendix 5 for the statistics) as a check on the stability of the factor results for the two different samples, the original sample and the sample of original plus new students. Comparison of the factor loadings in Table 5.2B (the total sample) with the factor loadings in Table A5.4 (subsample of original students) reveal very similar results in the two analyses. Thus, the factor pattern for the end-of-first-grade tests in the original sample is essentially the same as that for the combined sample of old and new students.

2. End-of-Second-Grade Scales

Description of Scales

The end-of-second-grade mathematics scales were drawn from three test forms, Forms 2-03, 2-04, and 2-05. Most of the mathematics scales given at the end of second grade were constructed by eliminating from the first grade scales items that were too easy and adding more difficult items that were appropriate to this grade. The scales that were modified forms of first grade scales were Number Comparison - Order (503), Place Value (504), Number Line (505), Application (506), Rationals (507), Computation - Addition (510), Computation - Subtraction (511), and Computation - Multiplication (512).

The items of Comprehension (502) were designed to measure the child's understanding of the relationships of set manipulations to arithmetic operations. Two of the items associated joining sets with the operation of addition; four items interpreted subtraction in relation to either set partitioning or removing objects from sets; and two items related multiplication to joining equivalent sets or to an array. The task required was the association of a number sentence with a picture. No items from the first grade comprehension scales were used for Scale 502, but the scale consisted of items of the same general type as those used in first grade.

One of the five geometry scales, Identifying Triangles (523), was identical to Scale 321 from first grade; the other four scales were constructed for second grade. Identifying Polygons (521) measured the child's ability to recognize a polygon. A score for Curved and Open Figures (522), which was derived from the same test as Identifying Polygons, was obtained by giving the child a point if he did not identify a curved or open geometric figure as a polygon. Congruence (524) required the child to pick out all the figures congruent to a given figure. To determine whether the child could differentiate the concept of congruence from similarity, a scale, Similarity (525), was constructed by giving the child a point whenever he did not select a figure similar to a given model when the task was to select the congruent figure.

Three of the scales given at the end of second grade were group versions of tests that had been given in kindergarten. These scales were Vocabulary (501), which measured knowledge of vocabulary related to mathematics, Ordering Pictured Sets - Group (508), which was analogous to Ordering Pictured Sets (139Z), and Counting (509), which measured cardinal counting as had Counting Members of a Given Set - Picture Cards (110) in kindergarten.

In addition to the mathematics scales, measures of reading and intelligence were also obtained. Reading scores were again obtained from the Stanford Achievement Test. During the second half of second grade, the Wechsler Intelligence Scale for Children (WISC) was administered to the children. The four subtests selected from the WISC were those corresponding to the four subtests of the WPPSI that had been administered in kindergarten. A short-form total scale for the WISC was obtained by adding together the scale scores for the four subtests.

Results of Factor Analyses

A factor analysis was performed for second grade scales measuring reading, intelligence, and mathematics. The scales were drawn from the mathematics tests (Forms 2-03, 2-04, and 2-05), the WISC, the SAT, and the K-A test. Since the K-A test was given at the beginning of second grade while the remaining tests were given in the second semester of second grade, one factor analysis was done with the K-A test and one without this test. The results of these two factor analyses were very similar and only the one with the K-A test is included in this report.

The results of the factor analysis for the second grade scales are given in Table 5.3A (means and standard deviations), Table 5.3B (factor loadings), and Table A5.6 (correlation matrix). The first factor, a general mathematics factor, which accounts for the highest proportion of variance, has loadings for

Table 5.3A

Means and Standard Deviations for Scales Used in Factor Analysis of End-of-Second-Grade Scales
Total Sample

Scales		Item N	MN	SD
Math Scales				
Vocabulary-Gp	501	23	17.50	3.35
Comprehend-Gp	502	8	4.60	1.89
No. Compare	503	8	5.16	1.92
Place Value	504	8	3.56	2.12
No. Line	505	7	3.74	1.41
Application	506	8	4.79	1.91
Rationals	507	8	3.57	1.55
Order Sets PC-Gp	508	3	1.61	1.21
Counting	509	2	1.76	0.50
Compute-Add	510	8	5.27	2.02
Compute-Subtract	511	8	4.35	2.11
Compute-Multiply	512	8	2.16	2.47
Ident Polygons	521	9	2.43	2.71
Curved and Open Figs	522	7	6.14	1.25
Ident Triangles	523	6	4.75	1.72
Congruence	524	4	3.60	0.88
Similarity	525	2	0.54	0.74
SAT Scales				
SAT Word #Rt	A301	36	17.47	7.48
SAT Paragraph #Rt	A303	60	28.25	12.72
WISC Scales				
WISC Vocabulary	M305	40*	10.99	3.33
WISC Similarities	M306	16*	11.34	3.28
WISC Pict Compl	M307	20*	10.07	2.75
WISC Block Design	M308	7*	11.03	3.02
Kuhlmann-Anderson				
IQ: Kuhl-Ander	M324	**	107.99	13.81

N = 760

*WISC means and standard deviations are from scaled scores with a range of 0 to 20.

**Kuhlmann-Anderson IQ is 67-180 for C.A. of 7-0 to 7-9.

Table 5.3B

Factor Loadings for End-of-Second Grade Scales
Total Sample

Scales		Factors 1	2	3	4	5
Math Scales						
Vocabulary-Gp	501	.62	.37			
Comprehend-Gp	502	.59				
No. Compare	503	.63	.35			
Place Value	504	.61	.38			
No. Line	505	.41				
Application	506	.67				
Rationals	507	.34	.31			
Order Sets PC-Gp	508	.62				
Counting	509					
Compute-Add	510	.75				
Compute-Subtract	511	.77				
Compute-Multiply	512	.59				
Ident Polygons	521					.43
Curved and Open Figs	522					-.34
Ident Triangles	523					.31
Congruence	524				-.46	
Similarity	525				.49	
SAT Scales						
SAT Word #Rt	A301	.41		.72		
SAT Paragraph #Rt	A303	.52		.70		
WISC Scales						
WISC Vocabulary	M305		.68			
WISC Similarities	M306	.35	.56			
WISC Pict Compl	M307		.49			
WISC Block Design	M308	.41	.42			
Kuhlmann-Anderson						
IQ: Kuhl-Ander	M324	.58	.36			
Percent of Total Variance		22	10	6	2	3

N = 760

Note: Factor loadings of less than .30 have been omitted from this table.

all of the mathematics scales except Counting (509) and the geometry scales (521-525). Computation - Addition (510) and Computation - Subtraction (511) have the highest loadings on this general mathematics factor. High loadings on factor 1 are also found for Vocabulary (501), Comprehension (502), Number Comparison (503), Place Value (504), Application (506), Ordering Pictured Sets (508), and Computation - Multiplication (512) of the mathematics scales, and IQ: Kuhlmann-Anderson (M324). Somewhat lower loadings are found for the Block Design scale of the WISC (M308), the SAT scales (A301 and A303), and Number Line (505). Low loadings are found for Rationals (507) and Similarities of the WISC (M306).

The second factor is characterized by the WISC intelligence scales with the highest loadings found for the verbal scales, Vocabulary (M305) and Similarities (M306). Very low loadings are found on this factor for the K-A test (M324), the mathematics vocabulary scale (501), Place Value (504), and two other mathematics scales. The third factor has loadings only for the reading scales.

The fourth and fifth factors are geometry factors. Factor 4 is marked by Congruence (524) and Similarity (525), but one scale has a positive loading while the other has a negative loading. The test from which the Congruence and Similarity scales were derived required the marking of all figures congruent to a given figure. The number of figures correctly identified gave the score for Congruence. For the Similarity scale, a point was given for each similar (but not congruent) figure that was not marked. The results of the factor analysis indicate that the concepts of congruence and similarity were generally not differentiated.[53] Two of the three scales appearing on the other geometry factor, factor 5, have very low loadings. A confusion between polygons and curved and open figures resembling polygons is indicated, however, by the negative relationship between the loadings on the scales Identifying Polygons (521) and Curved and Open Figures (522).

Comparison of Results of Factor Analyses for Scales Given in the Second Grade with Factor Analyses of First Grade Scales

The two factor analyses for the total samples in second grade and in first grade were quite similar. In both cases, there was a general mathematics factor accounting for the highest proportion of the variance which had loadings for

[53] Inspection of the frequency of checking all the items in this test showed that the negative relation between the Congruence and Similarity scales was not due to an indiscriminant marking of all figures in the test. The frequencies for checking figures that were not similar to the given figure were [ext]remely low.

almost all mathematics variables except the geometry scales, and with computation - addition and subtraction having the highest loadings. In both factor analyses, the K-A scale and the SAT scales appeared on the general mathematics factor and also had loadings of about the same order of magnitude in the two analyses.

In the factor analysis of second grade scales, some of the WISC scales were associated with mathematics scales, but the loadings for the K-A were higher than scales from the WISC. (The K-A test included items dealing with arithmetic; the WISC Arithmetic subtest was not used.) Although the Raven test had been found to correlate quite highly with the performance scales of the WISC, it did not play the same role in the first grade factor analysis, shown in Table 5.1B, that the WISC did for the second grade scales. In the analysis of first grade scales, the Raven scales failed to appear on the general mathematics factor. The factor on which the Raven scales did appear with the K-A test had loadings of three mathematics scales that were so low as to just pass the criterion of .30 required for inclusion in the tables. Thus, the WISC was more closely related to mathematics scales in the second grade than the Raven had been related to mathematics scales at first grade.

The appearance of geometry scales as separate factors was consistent in both analyses.

3. End-of-Third-Grade Scales

Description of Mathematics Scales

Two mathematics test batteries (Form 3-02 and 3-04) were given at the end of third grade. Most of the end-of-third-grade mathematics scales were either identical to or extensions of the second grade mathematics scales. Scales which remained the same as the second grade scales were: Place Value (702), Number Line (703), Rationals (705), and Computation - Multiplication (709). The scales Number Comparison - Order (701), Application (704), Computation - Addition (707), and Computation - Subtraction (708) were extensions of the corresponding scales given at the end of second grade. For the addition and subtraction scales, the easiest second grade items had been eliminated to form the third grade scales.

A new geometry scale, Structure of Space (706), replaced the previously used geometry scales. Scale 706 was designed primarily to ascertain whether pupils had command of certain fundamental concepts of Euclidean geometry. Six of the items were concerned with the concepts of point, line, and plane or their relationships; one item involved the identification of a solid figure; and one item dealt with the topological notion of "outside." All items were

multiple choice, and with one exception, each had an accompanying figure.

Structure (728) was constructed to measure understanding of the basic properties of arithmetic, as had the comprehension scales given in first and second grade of the study. Scale 728 measured knowledge of basic properites such as commutativity, associativity, distributivity, identity elements, and inverse elements with respect to addition and multiplication of whole numbers. The child had to supply an omitted number in a number sentence for each item of the test. Computation (727) was intended to measure ability to add, subtract, multiply and divide whole numbers, and to add or subtract simple fractions. The scales Structure (728) and Computation (727) had been used in NLSMA.[54]

Reliabilities for all of the end-of-third-grade mathematics scales, as measured by Cronbach's alpha, were .45 or greater. Number Line (703) and Structure of Space (706) had $\alpha = .45$; Number Comparison (701) had $\alpha = .55$; and Rationals (705) had $\alpha = .54$. The remaining scales had $\alpha > .60$.

<u>Results of Factor Analyses</u>

Two factor analyses were performed with the end-of-third-grade scales. In the first factor analysis, only the mathematics scales and the SAT scales given at the end of third grade were included. Since no intelligence test had been given at the end of third grade, a second factor analysis was performed for the end-of-third-grade scales with the K-A scale from the beginning of second grade and the WISC scales from the end of second grade added.

<u>Factor analysis of end-of-third-grade scales</u>. Means and standard deviations for the end-of-third-grade scales are shown in Table 5.4A and the factor loadings are given in Table 5.4B. Correlation matrices are shown in Table A5.7 in Appendix 5. Some mathematics scales appear on all the factors shown in Table 5.4B. The first factor, which accounts for 18 percent of the total variance, has computation scales as the variables with the highest loadings. The three scales with the highest loadings on this factor are Computation - Addition (707), Computation - Subtraction (708), and Computation (727). A slightly lower loading is found for Computation - Multiplication (709). Other mathematics scales having loadings on factor 1 are Application (704), Place Value (702), Structure (728), and Number Comparison (701), with a low loading. The two SAT Reading scales, A401 and A403, also appear on this factor but also with lower loadings.

[54] See <u>NLSMA Reports, No. 4</u> for the scale descriptions.

Table 5.4A

Means and Standard Deviations for Scales Used in Factor Analysis
of End-of-Third-Grade Scales
Total Sample

Scales		Item N	MN	SD
Math Scales				
No. Compare	701	8	4.84	1.79
Place Value	702	8	4.19	2.22
No. Line	703	7	3.78	1.30
Application	704	8	5.01	2.08
Rationals	705	8	4.14	1.80
Struct Space	706	8	4.35	1.70
Compute-Add	707	8	5.46	2.35
Compute-Subtract	708	8	4.35	2.34
Compute-Multiply	709	8	4.76	2.62
Computation	727	15	6.27	3.45
Structure	728	8	2.78	2.15
SAT Scales				
SAT Word #Rt	A401	36	22.87	7.71
SAT Paragraph #Rt	A403	60	37.46	13.29

N = 649

Table 5.4B

Factor Loadings for End-of-Third-Grade Scales
Total Sample

Scales		Factors 1	2	3	4
Math Scales					
No. Compare	701	.32		.45	
Place Value	702	.38	.31	.41	.46
No. Line	703			.38	
Application	704	.42		.50	.37
Rationals	705				.44
Struct Space	706		.34	.44	
Compute-Add	707	.66			
Compute-Subtract	708	.61	.30	.37	
Compute-Multiply	709	.50	.33		.43
Computation	727	.63	.31		.43
Structure	728	.36		.31	.53
SAT Scales					
SAT Word #Rt.	A401	.31	.74		
SAT Paragraph #Rt	A403	.37	.74	.31	
Percent of Total Variance		18	16	12	13

N = 649

Note: Factor loadings of less than .30 have been omitted from this table.

Structure (728) has the highest loading on factor 4, followed by Place Value (702), Rationals (705), and the two computation scales having the most difficult items, 709 and 727. (Computation (727) covered division, multiplication, and fractions, as well as items for addition and subtraction.) Application (704) had a low loading on factor 4. This factor seems to include the more difficult mathematics scales, while factor 1 includes the easier scales.

Factor 3, on which more than half the mathematics scales load, is difficult to characterize, although it appears to be more a comprehension factor by contrast to factor 1 that is most marked by computation scales. The highest loading is found for Application (704) and slightly lower loadings are found for Number Comparison (701), Structure of Space (706), and Place Value (702). Number Line (703), Computation - Subtraction (708), Structure (728), and SAT Paragraph Meaning Number Right (A407) are also found on this factor. The remaining factor, factor 2, is a reading factor with very high loadings for the SAT scales and very low loadings for a number of mathematics scales.

Factor analysis of end-of-third-grade scales with WISC and K-A scales. The results of the factor analysis of the end-of-third-grade scales, together with the two intelligence tests given in second grade, are given in Tables 5.5A and 5.5B. (The correlation matrix is shown in Table A5.8 in Appendix 5.) Addition of the intelligence scales results in some changes in the general pattern obtained when the factor analysis was performed without the intelligence scales. The mathematics factor, with the computation scales having the highest loadings, appears as factor 5 in Table 5.5B and accounts for slightly more of the total variance than did the corresponding factor, factor 1, in Table 5.4B. In both factor analyses, the Computation scales, Addition (707), Subtraction (708), and Computation (727), have the highest loadings on this mathematics factor, with Computation - Multiplication (709) following at a slightly lower level. The other mathematics scales and the SAT scales that appeared on factor 1 previously, shown in Table 5.4B, also appear on factor 5 in Table 5.5B. The only scale measuring intelligence appearing on this factor is IQ: Kuhlmann-Anderson (M324), and it has a very low loading. Factor 1 of the present analysis corresponds to factor 4 in the previous analysis; however, it now accounts for a much smaller percent of the total variance, and only the three leading variables, Structure (728), Rationals (705), and Place Value (702), still have loadings high enough to be included in the table. No intelligence scales are found on this factor.

Two intelligence factors were obtained. Factor 2, a verbal factor, is marked by Vocabulary (M305) and Similarities (M306) from the WISC. On factor 4, a performance factor, Picture Completion (M307) and Block Design (M308)

Table 5.5A

Means and Standard Deviations for Scales Used in Factor Analysis of End-of-Third-Grade, WISC and Kuhlmann-Anderson Scales

Total Sample

Scales		Item N	MN	SD
Math Scales				
No. Compare	701	8	4.87	1.78
Place Value	702	8	4.21	2.22
No. Line	703	7	3.79	1.32
Application	704	8	3.03	2.07
Rationals	705	8	4.12	1.79
[illegible]ruct Space	706	8	4.36	1.70
Compute-Add	707	8	5.49	2.33
Compute-Subtract	708	8	4.37	2.34
Compute-Multiply	709	8	4.77	2.60
Computation	727	15	6.31	3.45
Structure	728	8	2.79	2.14
SAT Scales				
SAT Word #Rt	A401	36	22.91	7.70
SAT Paragraph #Rt	[illegible]	60	37.62	13.21
WISC Scales				
WISC Vocabulary	M305	40*	10.94	3.32
WISC Similarities	M306	16*	11.37	3.20
WISC Pict Compl	M307	20*	9.99	2.67
WISC Block Design	M308	7*	10.96	2.97
Kuhlmann-Anderson				
IQ: Kuhl-Ander	M324	**	108.79	13.75

N = 614

*WISC means and standard deviations are from scaled scores with a range of 0 to 20.

**Kuhlmann-Anderson IQ is 67-180 for C.A. of 7-0 to 7-9.

Table 5.5B

Factor Loadings for End-of-Third-Grade, WISC and Kuhlmann-Anderson Scales
Total Sample

Scales		Factors					
		1	2	3	4	5	6
Math Scales							
No. Compare	701					.39	.31
Place Value	702	.31	.37			.50	
No. Line	703				.31		
Application	704		.30			.57	.32
Rationals	705	.35				.34	
Struct S[illegible]e	706			.31		.34	.33
Compute-[illegible]	707					.70	
Compute-Subtract	708					.69	
Compute-Multiply	709			.30		.61	
Computation	727					.73	
Structure	728	.39			.31	.47	
SAT Scales							
SAT Word #Rt	A401		.34	.67		.41	
SAT Paragraph #Rt	A403			.69		.44	
WISC Scales							
WISC Vocabulary	M305		.62		.31		
WISC Similarities	M306		.59				
WISC Pict Compl	M307				.49		
WISC Block Design	M308				.48		
Kuhlmann-Anderson							
IQ: Kuhl-Ander	M324			.31	.44	.37	
Percent of Total Variance		4	9	10	8	21	3

N = 614

Note: Factor loadings of less than .30 have been omitted from this table.

from the WISC, and IQ: Kuhlmann-Anderson (M324) appear. A few mathematics scales also are found on these factors, but the loadings are low.

Addition of intelligence scales to mathematics scales did not result in any appreciable change in the results discussed in the previous section for the factor analysis of mathematics and reading scales. The intelligence scales did not have high loadings on any of the mathematics factors but appeared on separate factors.

4. Summary: Comparison of Factor Analyses of First, Second, and Third Grade Scales

The pattern of results obtained in the factor analyses of each of the grades, first, second, and third, were quite similar. In each analysis a general mathematics factor was found which had its highest loadings for computation scales and somewhat lower loadings for all other mathematics scales, except those measuring the areas of geometry and rationals. The geometry scales were found on a separate factor in all analyses.

The reading scales from the SAT were found on the general mathematics factor in each analysis, generally with low loadings. The intelligence scales played different roles in the analyses in various years. The product-moment correlations between intelligence scales and the three computation scales were inspected for each year to determine whether the relationship between computation scores and intelligence scores differed from year to year. (See Tables A5.1 and A5.2 for correlation matrices for first grade scales, Table A5.6 for second grade scales, and Table A5.8 for third grade scales.) The correlations between the computation scales and the K-A test ranged between .31 and .55 across the three years, with the highest correlations, .52 - .55, occurring at second grade. The lowest correlation was between the K-A and multiplication at first grade.

The K-A test generally had higher correlations with computation scales in all three grades than did the other intelligence scales. This result would be expected since arithmetic items were included in the K-A test; it is also consistent with the fact that the K-A test appeared on the mathematics factor. The Raven test had the lowest correlations with the computation scales and, as a result, failed to appear on the mathematics factor. (Correlations between Raven and computation scales ranged from .22 - .33.)

Comparison of the correlations between Block Design of the WISC and the computation scales in second and in third grade showed that the correlations were higher for addition and multiplication in second grade than in third, and

Block Design was found on the mathematics factor only in second grade. (Block Design correlated .41, .39, and .47 with addition, subtraction, and multiplication, respectively, in second grade; correlations of .34, .43, and .39 were obtained in third grade.) Similarities, like Block Design, loaded on the mathematics factor only in second grade; and the range of correlation coefficients between it and the computation scales was somewhat higher at second grade (.34 - .39) than at third grade (.29 - .37).

In summary, the K-A scale had a moderately high loading on the general mathematics factor in the factor analyses of first and second grade scales and a lower loading in the factor analysis of third grade scales. The scales from the Raven test failed to appear on the general mathematics factor in the factor analysis of first grade scales. In the second grade analysis, two WISC scales, Block Design and Similarities, had low loadings on the general mathematics factor. When the WISC scales were factor analyzed with third grade scales, however, they failed to appear on the general mathematics factor. Neither Vocabulary nor Picture Completion of the WISC loaded on the general mathematics factor at second or third grade.

APPENDICES

APPENDIX 1

Table A1.1

Scales* Included in Factor Analyses in ELMA Report No. 1

BEGINNING-OF-KINDERGARTEN SCALES

Scale Code	Name of Scale	Reference Page in ELMA Technical Report No. 1
001	Geometric Shapes - Matching	255
002	Geometric Shapes - Naming	256
003	Geometric Shapes - Identifying	257
004	Counting Buttons	258
005	Writing Numerals	259
006	Counting Members of a Given Set - Picture Cards	260
007	Identification of Numerals	261
008	Visual Memory - Objects	262
010	Vocabulary (Individual)	263
012	Equivalent Sets - Dots	265
013	Ordinal Number	266
014	Ordering Geometric Shapes	267
015	Classifying	268
016	Rote Counting	269
017	Visual Memory - Pictures	270
019	Color - Matching	271
020	Color - Naming	272
021	Color - Identifying	273
022	Response to Verbal Directions	274
023	Attention to Tasks	275

(continued)

*NOTE: The scale descriptions and statistical properties of these scales may be found in ELMA Technical Reports on the pages noted in the last column.

Table A1.1
(second page)

END-OF-KINDERGARTEN SCALES

Scale Code	Name of Scale	Reference Page in ELMA Technical Report No. 1
104	Geometric Shapes - Identifying	286
110	Counting Members of a Given Set - Picture Cards	292
111	Counting Members of a Given Set - Objects	293
118	Equivalent Sets - Objects	299
119	Equivalent Sets - Dots	300
130	Classifying S-2	308
143	Response to Verbal Directions	316
144	Attention to Tasks	317
147	Ordering Composite	320
114W	Visual Memory - Objects	296
133W	Visual Memory - Picture Cards	310
135W	Visual Memory - Shapes	311
106X	Counting Buttons	288
108X	Writing Numerals	290
113X	Identification of Numerals	295
117X	Vocabulary (Individual)	298
102Y	Geometric Shapes - Naming	284
120Y	Ordinal Number	301
128Y	Classifying S-1	306
131Z	Visual Memory - Pictures	309
137Z	Ordering Sets of Objects	312
139Z	Ordering Pictured Sets (Individual)	313
146Z	Conservation Composite	319
M112	WPPSI Vocabulary Scaled Score	331
M114	WPPSI Similarities Scaled Score	332
M117	WPPSI Picture Completion Scaled Score	332
M120	WPPSI Block Design Scaled Score	333
R201	MRT Word Meaning Raw Score	338
R202	MRT Listening Raw Score	338
R203	MRT Matching Raw Score	338
R204	MRT Alphabet Raw Score	339
R205	MRT Numbers Raw Score	339
R206	MRT Copying Raw Score	339

(continued)

Table A1.1
(third page)

END-OF-FIRST-GRADE SCALES

Scale Code	Name of Scale	Reference Page in ELMA Technical Report No. 2
306	Place Value	213
307	Number Comparison (Order)	214
308	Number Line	215
309	Application	216
310	Rationals	217
311	Computation - Addition	218
312	Computation - Subtraction	219
313	Computation - Multiplication	220
317	Response to Verbal Directions	223
318	Attention to Tasks	224
321	Identifying Triangles	225
322	Identifying Rectangles	226
323	Curved Figures	227
328	Comprehension (Group)	232
329	Comprehension (Individual)	233
M201	Raven Set A	250
M202	Raven Set Ab	250
M203	Raven Set B	250
M324	Kuhlmann-Anderson I.Q.	253
A201	SAT I Word Reading Number Right	256
A205	SAT I Paragraph Meaning Number Right	256

(continued)

Table A1.1
(fourth page)

END-OF-SECOND-GRADE SCALES

Scale Code	Name of Scale	Reference Page in ELMA Technical Report No. 3
501	Vocabulary (Group)	226
502	Whole Number Comprehension	227
503	Number Comparison (Order)	228
504	Place Value	229
505	Number Line	230
506	Application	231
507	Rationals	232
508	Ordering Pictured Sets (Group)	233
509	Counting	234
510	Computation - Addition	235
511	Computation - Subtraction	236
512	Computation - Multiplication	237
521	Identifying Polygons	246
522	Curved and Open Figures	24[illegible]
523	Identifying Triangles	248
524	Congruence	249
525	Similarity	250
M305	WISC Vocabulary Scaled Score	263
M306	WISC Similarities Scaled Score	263
M307	WISC Picture Completion Scaled Score	263
M308	WISC Block Design Scaled Score	264
A301	SAT II Word Meaning Number Right	266
A303	SAT II Paragraph Meaning Number Right	266

(continued)

Table A1.1
(fifth page)

END-OF-THIRD-GRADE SCALES

Scale Code	Name of Scale	Reference Page in ELMA Technical Report No. 4
701	Number Comparison (Order)	132
702	Place Value	133
703	Number Line	134
704	Application	135
705	Rationals	136
706	Structure of Space	137
707	Computation - Addition	138
708	Computation - Subtraction	139
709	Computation - Multiplication	140
727	Computation	158
728	Structure	159
A401	SAT II Word Meaning Number Right	168
A403	SAT II Paragraph Meaning Number Right	168

APPENDIX 2.1

Inservice Consultant Questionnaire

Name ______________________________

Class Taught ______________________________

I. Organization of Inservice Course

A. Meeting Schedule

1. How many meetings did you have with this group of teachers?

____

2. What was the average length of meetings?

____

B. Material Covered

1. List the topics in the SMSG Studies in Mathematics (Vol. 9 or 13, whichever is pertinent) which you covered quite thoroughly in the classes.

____

____

____

____

2. List the topics from Studies in Mathematics which you dealt with, but which you felt could have used more time.

____

____

____

____

3. List any topics from the Studies in Mathematics which were not covered at all in the classes.

____

____

____

____

4. Kinds of questions most frequently asked. (Rank order, with highest frequency ranked 1.)

_____ Clarification of mathematics concepts

_____ Applications of concepts

_____ Use of materials

_____ Other (Specify _________________________

_____ _________________________

_____ _________________________

C. Participation by Aides

1. Describe the participation of the teacher aides in the inservice class meetings. Did they ask questions, participate in discussions, etc.?

____

____

____

2. Was the role of the teacher aide in the mathematics program in the classroom specified, or was this left to the discretion of the individual classroom teacher? Explain.

____

____

____

____

II. Description of Inservice Class Meetings

A. Division of Time between Mathematics and Teacher Consultants

1. Describe a typical class meeting. ____________

____

____

____

____

____

____

2. Was material typically presented in lecture fashion by the mathematics consultant, through questioning of teacher, or some other technique? Describe.

____

____

3. How much time was typically spent in the presentation of the mathematics background material?

____

4. How much time was allotted <u>at each meeting</u> for the teacher consultant to demonstrate and provide applications?

____

B. Participation by Teachers

1. Was time allotted at each meeting for questions from the teachers?

Yes ______ No ______

2. What was the <u>modal</u> time allotted for questions?

____

III. Follow-up to Inservice Course

Please describe the kinds and frequency of informal contacts which were maintained with classroom teachers either between inservice meetings or after the course was completed. If there were none, please specify.

IV. Comments

If you have comments about any issue or question related to the inservice program, here is your chance. We are willing to hear criticisms of this year's program, suggestions for organization of the next (second and third grade teachers) inservice course, or whatever feelings concerning the program you wish to express!

APPENDIX 2.2A

Kindergarten Teacher Questionnaire

Name ______________________________

School ______________________________

City ______________________________

1. a. Specify the kindergarten guide or book(s) you have used most for your mathematics program.

____

____

b. Which chapter of the book were you teaching on May 22?

(Please give page numbers.) ______________________________

Specify book if more than one given in 1a.

____

2. Have you, during the course of the school year, covered the material in the order as presented in the book you relied upon most? Please check a, b, or c, below, according to the description which best fits <u>your</u> <u>own</u> handling of the material.

Specify the book you are making rating upon.

____

_____ a. The order of topics in the book was followed.

_____ b. There were some changes in order of presentation of topics. (If b.), list changes in order of presentation.

Sections omitted: ______________________________

Sections further along in the book which you covered:

____

_____ c. The order followed in teaching was considerably different from the order in the book. (If c.), list sections covered.

____

3. List any sections or chapters in the book that have been covered more than once.

____

4. Approximately how much time has been devoted to mathematics teaching? Answer both a and b.

   a. Average number of days each week that mathematics has been taught:

      (Circle one.) 1 2 3 4 5

   b. Average amount of time spent on mathematics on each day that it has been taught:

      (Circle one) 1/4 hr. 1/2 hr. 3/4 hr. 1 hr.

5. Did you include mathematical ideas in other activities?

   Routinely ____ Occasionally ____ Infrequently ____

6. Did you divide your class into groups for teaching mathematics?

   Yes ____ No ____

   If Yes, please explain your organization of teaching in this way:

   ____

   ____

   ____

7. If you have had a teacher aide in your classroom as part of this program, please answer the following questions.

   a. How much time has your aide spent in your class each day?

      ____

   b. What have been the main activities of the teacher aide in your class?

      ____

      ____

      ____

      ____

APPENDIX 2.2B

First Grade Teacher Questionnaire

Name ______________________________

School ______________________________

City ______________________________

1. a. Specify the first grade text you have used most for your mathematics program.

   ____

   b. How far in the book were you when the fall semester ended? (Please give page numbers and specify whether you are referring to student workbook or teacher's commentary.)

   ____

   c. Which chapter of this book were you teaching on May 20? (If you only taught the children in the fall semester, omit this question.)

   ____

2. Have you, during the course of the school year, covered the material in the order as presented in the book you relied upon most? Please check a, b, or c, below, according to the description which best fits <u>your own</u> handling of the material.

   _____ a. The order of topics in the book was followed.

   _____ b. There were some changes in order of presentation of topics. (If b.), list changes in order of presentation.

   Sections omitted: ______________

   Sections further along in the book which you covered:

   ____

   _____ c. The order followed in teaching was considerably different from the order in the book. (If c.), list sections covered and order:

   ____

3. List any sections or chapters in the book that have been covered more than once.

____

4. How many of the pupil workbook pages did you have the children do in the book you relied on most?

_____ a. All or almost all of the workbook pages were used.

_____ b. Part of the workbook pages were used. (If b.), please give approximate percentage used. _______

_____ c. Pages were omitted for specific sections or chapters. (If c.), please list sections for which pages were omitted.

_________________ _________________

_____ d. Other possibilities for use of workbook pages, e.g., used about all with certain groups and only a few with other groups within class. (If d.), please explain your use of the workbook.

____

____

____

5. Did you make up extra work pages for the children to do? (Please indicate approximate number of pages and topic areas covered.)

____

____

____

6. a. Were there some topics which you emphasized especially by devoting a great deal of time to them? (Please enumerate.)

____

____

b. Were there some topics on which you spent relatively little time?

____

____

7. To what extent did you introduce lessons with pre-book activities (developmental experiences) suggested at the beginning of each section in the teacher's commentary that you used most frequently?

_____ a. Almost all the suggestions for introducing the lessons were used.

_____ b. Some of the suggestions were followed. (Please indicate proportion of lessons introduced as suggested by teacher's commentary.)

____

_____ c. Made no use or little use of suggested activities

_____ d. Used only for some specific groups in the class. (If d.), please explain for which groups pre-book activities were used.

____

____

____

8. To what extent did you use supplemental experiences (further activities) suggested in the teacher's commentary at the end of each section?

_____ a. Almost all of the additional activities were used to supplement the lessons.

_____ b. Some of the supplemental experiences were provided. (Please indicate proportion and topics of additional activities used.)

____

____

_____ c. No use or almost no use was made of additional activities following the main lesson.

_____ d. Additional activities were used for certain groups. (If d.), please explain.

____

____

____

9. Give the names of teacher guides and student workbooks used in addition to the one you used the most. Also, give some indication of the extent to which these were used, and with which particular groups of children.

____

____

____

____

____

10. If you made little use of any published text, please check here and describe your program briefly at the end of the questionnaire. ______

11. a. How frequently did you include mathematical ideas in other activities?

Routinely ____ Occasionally ____ Infrequently ____

b. Please describe briefly how you included mathematical ideas in other school subject areas or activities. (Specify the subject areas or activities in which mathematics was used and examples of how it was done.)

____

____

____

____

____

____

____

____

____

____

12. Please check category which best describes the use of manipulable objects by children during mathematics lessons.

_____ a. No materials (set of objects and/or counting blocks) used by children at their desks.

_____ b. Some objects available part of the time, or for some groups of children. Explain briefly.

____

____

____

_____ c. All children have objects on their own desks to use whenever needed.

Additional Comments:

Teacher Observation Form

Teacher's Name ______________________ Date ______________

School and City ______________________ Observer ______________

I. Teacher's management of the mathematics program she is using.

Topic (with rating)	Comments
1. Adherence to the contents of the mathematics program she is expected to use (SRA or SMSG). _____ 1 Minimal adherence _____ 2 _____ 3 Moderate _____ 4 _____ 5 Very strict adherence _____ 6 Mixed, depending upon ability groups. (Explain.) (Note in comments any other curriculum materials, e.g., Winston or Silver-Burdett, teacher may be using.)	

Topic (with rating)	Comments
2. Use of Teacher Commentary. Reliance on both background and suggestions provided by the program's Teacher Commentary. ____ 1 Minimal apparent reliance on T.C. ____ 2 ____ 3 Moderate reliance ____ 4 ____ 5 Very heavy apparent reliance on T.C. ____ 6 Varies with ability groups. (Explain.)	
3. Availability of manipulable objects to children. ____ 1 No materials (set objects and/or counting blocks) for each child to use at his desk while teacher is explaining or the child is doing seat work. ____ 2 ____ 3 Some objects available either part of the time or for some groups of children. ____ 4 ____ 5 All children have objects on their own desks to use whenever needed.	

Topic (with rating)	Comments
4. Clarity of teacher's presentation. _____ 1 Unclear; probably very confusing to children. _____ 2 _____ 3 Moderately clear _____ 4 _____ 5 Very clear	
5. Application of ideas; use of math in other subject areas. _____ 1 Math taught as separate subject without any relevance to other subjects; and/or no application of ideas to concrete problems. _____ 2 _____ 3 Some use of math in other activities, and/or meaningful applications. _____ 4 _____ 5 Evidence of math ideas being brought into many other activities (language, art, etc.) and many applications to problems. _____ 6 No opportunity to observe.	

Topic (with rating)	Comments
6. Reliance on didactic or discovery approach.	
____ 1 Teacher lectures completely, no drawing out of children's ideas through questioning.	
____ 2	
____ 3 Teacher relies about equally on didactic and discovery methods.	
____ 4	
____ 5 Teacher relies totally on discovery, i.e., draws out children to figure out problems through her questioning of them.	
7. Handling of combination (mixed 1st and 2nd, or 2nd and 3rd grade) classes.	
____ 1 Children taught math in separate groups <u>by grade</u> but can also hear the lesson for the other grade group if they so desire.	
____ 2 Children are taught math in separate groups <u>by grade</u> and are separated so that they are exposed only to the appropriate grade level lesson.	
____ 3 Children are grouped <u>across grade</u> level but can listen to the lesson for the other group(s) if they so desire.	
____ 4 Children are grouped <u>across grade</u> level but are separated so that they are exposed only to the lesson which they are directly taught.	

Topic (with rating)	Comments
8. Individuality of instruction; applicable to all classes. _____ 1 Teaches math to entire class as a unit. _____ 2 _____ 3 Some grouping; or grouping part of the time. _____ 4 _____ 5 Teaches within small groups only.	
9. Children's interest and attention. _____ 1 Children's interest low; attention appears to wander often. _____ 2 _____ 3 Moderate interest, involvement. _____ 4 _____ 5 Children appear very involved and attentive to math instruction. _____ 6 Mixed reactions (e.g., higher groups more interested or vice-versa). (Explain.)	

II. Progress.

A. Length of mathematics period ______________. Is mathematics period the same length each day?

Yes ____ No ____. If No, explain. ______________________________

B. How many times per week is mathematics taught? ______________

C. Topic teacher teaching on the day of observation. Specify Teacher Commentary pages, pupil pages and topic.

Is this a review lesson? Yes ____ No ____

Is teacher covering topics in the order in which they are presented in the Teacher Commentary?

Yes ____ No ____. If No, what order has she used?

D. Describe the mathematics lesson you observed.

III. Judgment of effectiveness.

A. Apart from communicating a specific mathematics program to a particular group of children, how good or effective a teacher is this teacher?

_____ 1 Ineffective

_____ 2

_____ 3 Moderately effective

_____ 4

_____ 5 Very effective

B. Explain, if possible, the specific elements of behavior you are drawing on from your observations to make the above evaluation:

APPENDIX 2.4*

Comparison of SRA and SMSG Curricula by Topical Areas Tested

Both the SMSG and the SRA series for K-3 may be classified as "modern" rather than "conventional" or "traditional." In this sense, the two series are more alike than different. But there are some consequential ways in which the SMSG and SRA curricula are not the same.

The following material summarizes similarities and differences between the two curricula for areas of work systematically tested during the course of the ELMA investigation. Although the categories are not mutually exclusive, they cover the curriculum topics tested:

Geometry
Place Value
Rational Numbers
Number Line
Number Comparison
Computation
Comprehension
Application

GEOMETRY

The amount of experience in SMSG is quite extensive and embraces three facets: nonmetric geometry, metric geometry (measurement), and coordinate geometry.

The amount of experience in SRA is quite limited, being restricted almost exclusively to a narrow aspect of metric geometry.

Although the topic of United States money does not properly belong under the heading of geometry, it frequently is viewed as an aspect of measurement and is so classified here.

Nonmetric Geometry

Kindergarten

In SMSG the recognition of familiar shapes (circular, rectangular, triangular, square) is introduced, along with concepts such as "inside," "outside," and "on."

*Acknowledgement is gratefully made to J. F. Weaver for this analysis of of the topical differences between the two curricula.

In SRA informal material on points and lines is introduced. Attention also is given to the recognition of circular, square, triangular, and rectangular shapes.

Book 1

Attention is given in SMSG to familiar three-dimensional shapes; to simple closed curves, including circles and several classes of polygons (e.g., triangles, rectangles, squares); to circular, triangular, rectangular, and square regions; and to regions that have the same size and shape (informal introduction to congruence).

No such work with nonmetric geometry is included in SRA.

Book 2

In SMSG work with sets of points is extended to include the concepts of line segment, line, ray, and angle, and includes ways of naming such configurations. Systematic consideration is given to the congruence of line segments, of angles (including the concept of a right angle), and of triangular, rectangular, and square regions.

No such work with nonmetric geometry is included in SRA.

Book 3

In SMSG work with sets of points is extended to include further classification of polygons (e.g., quadrilaterals), and to include special classes of triangles: isosceles, equilateral, and right triangles.

No such work with nonmetric geometry is included in SRA.

Metric Geometry (Measurement)

Kindergarten

In SMSG gross comparison of lengths (or heights) and sizes of physical objects is introduced.

In SRA gross comparison of sizes of physical objects and two-dimensional shapes is introduced.

Book 1

SMSG includes a relatively extensive introduction to linear measurement, with emphasis upon the fundamental nature of measurement as comparison. Work with the measurement of line segments is restricted to the use of arbitrary, nonstandard units.

SRA includes work with time, linear measure, and liquid measure. Formal statements of equivalent measurements involving standard units are made; e.g., 12 inches $\stackrel{m}{=}$ 1 foot, 3 quarts $\stackrel{m}{=}$ 6 pints. The specific units considered are: hour, half-hour; day, week, month; inch, foot; pint, quart.

Book 2

SMSG provides a substantial extension of its work with linear measurement, leading to the use of standard units for the measurement of line segments (inch and foot in particular). The thermometer is introduced as an application of a linear scale, leading to an informal consideration of negative integers.

SRA extends its work with time, linear measure, and liquid measure by introducing additional standard units: quarter-hour, five minutes; year; yard, cup, gallon. Compound units are used; e.g., 4 feet $\stackrel{m}{=}$ 1 yard and 12 inches.

Book 3

SMSG includes relatively extensive attention to the measurement of lengths of curves, leading to the perimeters of polygons. Compound units are used, and fractional units are introduced (e.g., half-inch, quarter-inch). The concept of area is introduced, and informal experience is provided in finding the area of polygonal regions using nonstandard units.

SRA extends its work with time, linear measure, and liquid measure to include the following standard units: half-inch, quarter-inch; half-gallon.

U. S. Money

Book 1

SMSG gives limited consideration to dimes and cents as applications of tens and ones groupings.

SRA includes work with pennies, nickels, and dimes. The symbol ¢ is used.

Book 2

SMSG provides limited extension which includes the use of the symbols ¢ and \$ in writing money amounts.

SRA includes a systematic extension to include the quarter and the half-dollar. Money amounts continue to be less than one dollar.

Book 3

No systematic extension is included in SMSG.

The dollar is introduced in SRA, along with the symbol \$

Coordinate Geometry

Book 3

SMSG introduces first-quadrant coordinate geometry with a substantial unit limited to whole number coordinates.

No such material is included within SRA.

PLACE VALUE

The amount of experience in SMSG is relatively limited, particularly in Books 1 and 2.

The amount of experience in SRA is relatively extensive in each of Books 1, 2, and 3.*

Book 1

SMSG includes numbers through 99. Expanded notation is not used.

SRA includes numbers through 100. Expanded notation is introduced and used recurringly.

Book 2

SMSG extends work to include the hundreds' place; however, 457 is the largest number encountered in any exercise. Expanded notation is introduced and used.

SRA extends work to include numbers through 999.

Book 3

SMSG extends coverage to include numbers through 9,999.

SRA extends coverage to include numbers through 9,999,999.

*A unique pictorial representation, the Counting Man, appears in SRA in connection with all but the most advanced work on place value (numbers 10,000 through 9,999,999); however, this device was not used in the SRA classes in City 1.

RATIONAL NUMBERS

The SMSG series provides much more extensive work with rational (fractional)* numbers than does the SRA series.

Each series associates fractional numbers with partitions of plane regions, with partitions of single physical objects, and with partitions of sets of physical objects. The last of the associations is given much more emphasis in SMSG than in SRA, however, and leads to extensive work in SMSG with the relationship between fractional numbers and quotients in division; i.e.,

$\frac{a}{b} = a \div b$, where a and b are whole numbers such that $b \neq 0$.

This relationship is not considered explicitly anywhere within the SRA series.

<u>Book 1</u>

SMSG includes the fractions $\frac{1}{2}$, $\frac{2}{2}$, $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{3}$.

SRA includes the fractions $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{3}$.

<u>Book 2</u>

SMSG, through its emphasis upon the relationship between rational numbers and division, extends work to include a wide variety of numerators and denominators (e.g., $\frac{20}{4}$, $\frac{24}{8}$, $\frac{18}{9}$, $\frac{10}{3}$, $\frac{13}{6}$).

SRA extends work to include the fractions $\frac{3}{4}$ and $\frac{2}{3}$.

<u>Book 3</u>

SMSG continues to extend its work to include fractions involving larger numerators and denominators.

SRA extends its work to include the fractions $\frac{2}{2}$, $\frac{3}{3}$, $\frac{2}{4}$, $\frac{4}{4}$; also, 6ths and 8ths.

---

*Both SMSG and SRA use the term "fraction" to refer to the name or symbol for a number. In SMSG, fractions are names for <u>rational</u> numbers; in SRA, fractions are names for <u>fractional</u> numbers.

As indicated further in the following section, SMSG associates fractional (rational) numbers with appropriate points of a line; SRA does not.

NUMBER LINE

SMSG includes relatively extensive associations of numbers with points of a line. SRA includes no such associations explicitly.

Book 1

SMSG introduces the association of whole numbers with appropriate points of a line. These associations are used in connection with ordering the whole numbers, and in connection with adding and subtracting whole numbers.

SRA has no explicit work with a number line.

Book 2

SMSG extends its work to include the association of fractional (rational) numbers with appropriate points of a line. These associations are used in connection with the ordering of such numbers.

SRA has no explicit work with a number line.

Book 3

SMSG continues to emphasize the association of whole and rational numbers with appropriate points of a line.

SRA has no explicit work with a number line.

NUMBER COMPARISON

Kindergarten

The comparison and ordering of sets of physical objects establishes readiness in both SMSG and SRA for the comparison and ordering of whole numbers.

Book 1

In SMSG whole numbers through 99 are compared and ordered, with the place value principle used to advantage in this connection.

In SRA whole numbers through 100 are compared and ordered, with the place value principle used to advantage in this connection. The symbols $>$ and $<$ are introduced and used.

Book 2

SMSG extends the comparison and order of whole numbers through 999, and also introduces and uses the symbols $>$ and $<$.

SRA extends the comparison and order of whole numbers through 999.

Book 3

SMSG extends the comparison and order of whole numbers through 9,999. The symbols > and < are used to compare and order fractional (rational) numbers as well as whole numbers, with the number line being used in this connection.

SRA extends the comparison and order of whole numbers through 9,999,999. The symb > and < are used to compare and order fractional numbers as well as whole numbers. The number line is not used in this connection.

COMPUTATION

Two general observations are appropriate to make at the outset of this section.

1. For each of the operations with whole numbers (addition, subtraction, multiplication, division), appreciably more practice exercises are included in the SRA pupil books than in the SMSG pupil books.

2. In the development of algorithms for adding, subtracting, multiplying, and dividing with numbers of two or more digits, there is a clear tendency in each series to move from algorithms which utilize expanded notation to shorter, more or less standard algorithms.

Addition and Subtraction with Whole Numbers

Book 1

In SMSG the work is restricted to basic facts having sums less than or equal to 10. Exercises appear only in horizontal form and do not involve more than two addends. The terms "addition" and "subtraction" are used, along with the corresponding symbols + and - . Number sentences are termed "equations."*

In SRA the work includes basic facts having sums less than or equal to 18, and is extended to computations involving more than two addends, and to

*Words or expressions within quotation marks refer to terms as used in a particular curriculum series and are identified when they first appear in that series. Not all variations of a term are mentioned, however. For instance, when the term "addition" is identified, variants such as "add" and "adding" may appear in the series also, even though not mentioned explicitly in this report. The term "addend" is sufficiently distinct, however, to warrant explicit identification here when it appears in a series. No attempt has been made in this report to identify all terms used in a particular series.

computations involving 2-place addends and sums without regrouping/renaming tens and ones.* Examples appear in vertical as well as in horizontal form. The terms "addition" and "subtraction" are used, along with the corresponding symbols + and - . Number sentences are called "equations." Other terms used include "sum," "addend," and "difference."

Book 2

In SMSG the work with basic facts is extended through sums of 18. Other extensions embrace: computation with more than two addends; computation involving 2-place addends, including "regrouping" and "renaming" of tens and ones (with sums exceeding 99 in addition but not in subtraction); and introduction and use of vertical algorithms for addition and subtraction. Terms introduced and used include "sum" and "addend."

In SRA the work with addition and subtraction is extended as far as 3-place addends and sums, including all "carrying" and "borrowing" complexities (e.g., carrying to or borrowing from both tens and hundreds within the same example).

Book 3

In SMSG the computing of sums and differences is extended to involve numbers not greater than 9,999, including all regrouping/renaming complexities.

In SRA the computing of sums and differences is extended to involve numbers not greater than 9,999,999, including all carrying and borrowing complexities.

Multiplication and Division with Whole Numbers

Book 1

In SMSG multiplication is introduced but division is not. The term "multiplication" is introduced and used, along with the symbol × . The amount of work is limited and is restricted to multiplication sentences involving factors 1 through 10.

In SRA neither multiplication nor division is introduced.

*Regrouping applies to sets of objects; renaming applies to numerals. The particular regroupings and renamings that are of concern in this section are those in which, for instance, 10 ones is changed to 1 ten (often termed *carrying* within the context of addition) or 1 ten is changed to 10 ones (often termed *borrowing* within the context of subtraction).

Book 2

In SMSG work with multiplication is continued, still principally within the context of basic facts. Exercises appear in horizontal form, as equations. Division is introduced, also principally within the context of basic facts. Fractional notation is used to indicate division: e.g., $\frac{6}{2} = 3$. (The form $6 \div 2 = 3$ is not used.) Terms include "factor," "product," "division," and "quotient."

Both multiplication and division are introduced in SRA. Content is restricted to the context of basic facts in which neither factor exceeds 5. Multiplication exercises appear in both horizontal and vertical forms, e.g.,

$$5 \times 2 = 10 \qquad \text{and} \qquad \begin{array}{r} 2 \\ \times\ 5 \\ \hline 10 \end{array}$$

Division exercises are stated horizontally in the familiar way, e.g., $6 \div 2 = 3$. (The form $\frac{6}{2} = 3$ is not used.) Terms include "multiplication," "division," "factor," and "product."

Book 3

In SMSG multiplication is extended to include exercises in which one factor is a number less than 10 and the other factor is a multiple of 10 or 100, or a whole number between 10 and 20. The extension also includes instances in which one factor is 10 and the other is a number between 10 and 100. Multiplications involving three factors are introduced. A vertical algorithm for multiplication is used for the first time. In connection with division the symbol $\div$ is introduced, as is a vertical algorithm for computing quotients.* Work is done mostly within the context of basic facts, but limited experience is provided with exercises involving multiples of 10 and with exercises in which quotients are not whole numbers. The term "divisor" is introduced and used.

In SRA the remaining multiplication and division basic facts are considered. Multiplication computations are extended to include those in which one factor is a number less than 10 and the other is a number between 100 and 1000. A vertical algorithm for computing quotients is introduced,* and division computations (no remainders) are extended to include those in which the known factor is a number less than 10 and the product is a number between 100 and 1000.

*The SMSG and SRA division algorithms for computing quotients are the same in principle.

COMPREHENSION

There is a very real sense in which, in both SMSG and SRA, comprehension has been a principal concern in each of the preceding sections of this chapter. At this point we wish to give more explicit consideration to two aspects of number work which contribute much to comprehension: (1) ways in which the operations of addition, subtraction, multiplication, and division are interpreted, and (2) the operational properties which are introduced and used.

Interpretations of Operations

The following table indicates the book in which an interpretation first receives explicit attention. In each instance an interpretation receives continuing attention following its introduction.

	SMSG	SRA
Addition		
Interpreted in relation to set union	Book 1	Book 1
Interpreted in relation to the number line	Book 1	------
Subtraction		
Interpreted in relation to set separation	Book 1	Book 1
Interpreted in relation to the number line	Book 1	------
Interpreted in relation to set comparison	Book 1	Book 1
Informally related to addition	Book 1	Book 1
Missing addend interpretation	Book 2	Book 1
Multiplication		
Interpreted in relation to rectangular arrays	Book 1	------
Interpreted in relation to set union	Book 1	Book 2
Interpreted in relation to addition	Book 2	Book 2
Division		
Interpreted in relation to rectangular arrays	Book 2	------
Interpreted in relation to set partitioning	Book 2	Book 2
Interpreted in relation to subtraction	Book 2	Book 2
Informally related to multiplication	Book 2	Book 2
Missing factor interpretation	Book 2	Book 2

Properties

The following table indicates the book in which a property first receives implicit or explicit attention, regardless of whether or not it is named as such. In each instance a property receives continuing attention and use following its introduction.

	SMSG	SRA
Addition		
Commutativity	Book 1	Book 1
Zero as identity element	Book 1	Book 1
Associativity	Book 2	Book 1
Subtraction		
Zero in subtraction ($a - 0 = a$; $a - a = 0$)	Book 1	Book 1
Multiplication		
Commutativity	Book 1	Book 2
One as identity element	Book 1	Book 2
Zero in multiplication ($a \times 0 = 0$)	Book 2	Book 2
Associativity	Book 3	Book 3
Distributivity with respect to addition	Book 2	Book 3
Division		
One in division ($a/a = 1$ [$a \neq 0$], $a/1 = a$)	Book 2	Book 2

APPLICATION

Neither program provides as much experience with so-called story problems as is found in many conventional or traditional texts.* Some of the experience with story problems in SMSG and SRA is incorporated in certain developmental and supplementary activities on a more or less incidental basis. Material explicitly designated as story problem instruction is decidedly limited in each series.

*Traditional texts include understanding of money and telling of time within application. In both SMSG and SRA, however, these are included as extensions of measurement.

Book 1

In SMSG there is one section in each of two chapters that is explicitly designated as problem solving. Emphasis is placed upon writing an equation that fits a problem and may then be used to solve that problem.

In SRA there is only one explicitly designated bit of work (two pages) concerning story problems. This is within the context of money and does not involve any related equations.

Book 2

In SMSG there is one section in each of three chapters that is designated explicitly as problem solving. Continued emphasis is given to the use of appropriate equations when solving problems.

In SRA one or more story problem pages are included in 15 or more different places within the text. Emphasis is upon a 4-step problem solving procedure which does not include writing an equation that may be associated with the problem.

Book 3

In SMSG there is one section in each of three chapters that is designated explicitly as problem solving. Emphasis upon use of equations is continued.

In SRA explicit attention to story problems, utilizing a step-by-step procedure, receives approximately the same extent of consideration as is the case in Book 2.

APPENDIX 3.1

Administrative Personnel
in the Participating School Districts

Oakland Public Schools

Mr. Donald Anderson	Director, Elementary Schools
Dr. Alden Badal	Director of Research
Dr. Spencer Benbow	Superintendent
Miss Maude Coburn	Supervisor, Elementary Education
Mr. Edward Cockrum	Assistant Superintendent
Miss Helen Curran	Teacher on Special Assignment
Mr. Edwin Larsen	Assistant in Research
Dr. Donald Madsen	Coordinator, Elementary Education
Dr. Stuart Phillips	Superintendent

San Francisco Unified School District

Mrs. Phyllis Abad	Curriculum Assistant, Elementary Mathematics
Dr. Joseph B. Hill	Curriculum Coordinator
Miss Agatha Hogan	Supervisor
Dr. Robert E. Jenkins	Superintendent
Mr. Yvon Johnson	Director of Research
Miss Tennessee Kent	Assistant Superintendent
Mr. Lawrence Lew	Research Assistant, Testing
Mrs. Doris Linnenbach	Resource Teacher
Miss Lee Mahon	Director of Elementary Education
Dr. Mary McCarthy	Supervisor
Dr. Raymond J. Pitts	Assistant Superintendent for Instructional Development and Services
Dr. Donald Rhodes	Assistant Superintendent
Mr. Victor Rossi	Supervisor
Dr. Harold Spears	Superintendent
Mrs. Dorothy Vukota	Supervisor
Mr. Harold Weeks	Director of Research

APPENDIX 3.2

Elementary School Principals
in the Participating School Districts

Oakland Public Schools

Mr. Howard Blethen	Edison, Piedmont
Mr. Curtis Blose	Emerson
Mrs. Jean Disher	Chabot
Dr. William Dunlap	Fruitvale
Mrs. Ioma Dunstan	Hillcrest, Rockridge
Mr. John Favors	Peralta
Mrs. Dorothy Gebhard	Hillcrest, Rockridge
Dr. Vern Green	Golden Gate
Mr. Norman Hohl	Allendale
Mrs. Pauline Hoover	Chabot
Dr. Benjamin Jefferson	Emerson, Longfellow
Mr. Angelo Lievors	Santa Fe
Mr. John Lievors	Allendale
Mrs. Madge Martin	Cleveland
Miss Bernice McCarthy	Franklin
Mr. James McCrohan	Lakeview
Mrs. Helen McDonald	Kaiser, Thornhill
Miss Carolyn Murphy	Crocker-Highlands
Mr. Keith Perkins	Longfellow
Mr. Walter Rowson	Golden Gate
Mr. Charles Schmuck	Kaiser, Thornhill
Mr. Sherman Skaggs	Fruitvale
Mr. Robert Smith	Allendale
Mr. John Speakman	Peralta
Mr. Arthur Swensen	Edison, Piedmont
Miss Ismay Tobin	Bella Vista
Mr. Alfred Valdix	Longfellow
Mr. Marveyn Weiner	Washington
Mrs. Roberta Wittlorp	Lakeview

San Francisco Unified School District

Miss Mary Anastole	Francis Scott Key
Mr. Donald Anderson	Burnett
Mrs. Patricia Crocker	Sir Francis Drake
Mr. Felix Duag	Raphael Weill
Mrs. Marion Heimsoth	Lawton
Mr. Michael Holway	Golden Gate
Miss Tennessee Kent	Robert Louis Stevenson
Miss Kathryn Lockhart	Sir Francis Drake
Mrs. Frances Lyons	Ulloa
Mrs. Marion Maginnis	Ralph Waldo Emerson
Miss Aileen McCarthy	Robert Louis Stenvenson
Mrs. Betty McNamara	Jedediah Smith
Miss Julia Merrell	Phoebe Apperson Hearst, Noriega Home
Mrs. Elfrida Nolan	Golden Gate
Mrs. Aurora Robbins	Ulloa
Mr. James Robinson	Bret Harte
Miss Eugenia Rolph	Jedediah Smith
Mr. George Ryan	John Swett
Miss Virginia Sullivan	Francis Scott Key
Mrs. Virginia Wales	Raphael Weill
Mrs. Martel Williams	Jedediah Smith

APPENDIX 4

Auxiliary Tables for Chapter 4

Table A4.1
Reduced Correlation Matrix for Beginning-of-Kindergarten Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 001 GEO SHAP:NAME	0.08	0.12	0.16	0.18	0.07	0.13	0.16	0.02	0.17	0.13	0.15	0.09	0.19
2 002 GEO SHAP:MATCH		0.36	0.53	0.30	0.23	0.20	0.29	0.11	0.35	0.20	0.28	0.18	0.40
3 003 GEO SHAP:IDFY			0.35	0.28	0.18	0.22	0.27	0.13	0.34	0.20	0.23	0.18	0.39
4 004 COUNT BUTTONS				0.63	0.41	0.58	0.67	0.02	0.46	0.47	0.49	0.34	0.47
5 005 WRITE NUMERALS					0.33	0.33	0.49	0.09	0.25	0.26	0.35	0.26	0.34
6 006 COUNT MEMS:PC						0.41	0.48	0.02	0.35	0.40	0.32	0.25	0.41
7 007 IDFY NUMERALS							0.55	0.03	0.42	0.42	0.46	0.33	0.45
8 008 VIS MEMRY:OBJS								0.07	0.10	0.03	0.07	0.06	0.09
9 010 VOCABULARY									0.38	0.33	0.45	0.31	0.46
10 012 EQIV SETS:DOTS										0.35	0.35	0.29	0.40
11 013 ORDINAL NUMBER											0.42	0.35	0.44
12 014 ORDRG:GEO SHAP												0.21	0.35
13 015 CLASSIFYING													0.45

	14	15	16	17	18	19	20
1 001 GEO SHAP:NAME	0.11	0.04	0.16	0.11	0.14	0.09	-0.05
2 002 GEO SHAP:MATCH	0.24	0.13	0.09	0.30	0.25	0.22	-0.17
3 003 GEO SHAP:IDFY	0.21	0.17	0.16	0.31	0.28	0.21	-0.16
4 004 COUNT BUTTONS	0.47	0.16	0.16	0.49	0.45	0.39	-0.28
5 005 WRITE NUMERALS	0.44	0.13	0.08	0.23	0.19	0.19	-0.17
6 006 COUNT MEMS:PC	0.35	0.16	0.12	0.37	0.36	0.28	-0.18
7 007 IDFY NUMERALS	0.47	0.14	0.15	0.46	0.42	0.32	-0.25
8 008 VIS MEMRY:OBJS	0.04	0.17	0.08	0.04	0.05	0.11	-0.14
9 010 VOCABULARY	0.31	0.16	0.17	0.37	0.37	0.28	-0.23
10 012 EQIV SETS:DOTS	0.30	0.17	0.16	0.30	0.25	0.38	-0.29
11 013 ORDINAL NUMBER	0.49	0.11	0.10	0.28	0.25	0.25	-0.25
12 014 ORDRG:GEO SHAP	0.25	0.09	0.10	0.21	0.22	0.18	-0.14
13 015 CLASSIFYING	0.35	0.20	0.17	0.40	0.36	0.33	-0.29
14 016 ROTE COUNTING	0.38	0.13	0.11	0.29	0.27	0.23	-0.21
15 017 VIS MEMRY:PICT		0.10	0.07	0.11	0.09	0.16	-0.15
16 019 COLOR:MATCH			0.13	0.21	0.28	0.23	-0.18
17 020 COLOR:NAMING				0.71	0.82	0.31	-0.22
18 021 COLOR:IDFYING					0.70	0.30	-0.22
19 022 RSPNS VRBL DIR						0.46	-0.61
20 023 ATTN TO TASKS							0.40

Table A4.2
Reduced Correlation Matrix for Beginning-of-Kindergarten, WPPSI and MRT Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 001 GEO SHAP:NAME	0.09	0.12	0.15	0.16	0.07	0.10	0.18	-0.00	0.13	0.09	0.17	0.09	0.18
2 002 GEO SHAP:MATCH		0.37	0.51	0.30	0.22	0.18	0.31	0.09	0.38	0.16	0.28	0.17	0.40
3 003 GEO SHAP:IDFY			0.33	0.25	0.11	0.20	0.25	0.06	0.33	0.14	0.18	0.18	0.36
4 004 COUNT BUTTONS				0.62	0.37	0.57	0.67	-0.02	0.46	0.46	0.49	0.33	0.46
5 005 WRITE NUMERALS					0.32	0.33	0.47	0.06	0.26	0.22	0.30	0.24	0.33
6 006 COUNT MEMS:PC						0.41	0.49	0.02	0.35	0.42	0.33	0.22	0.38
7 007 IDFY NUMERALS							0.60	0.02	0.41	0.41	0.45	0.30	0.44
8 008 VIS MEMRY:OBJS								0.67	0.05	-0.02	0.06	0.06	0.06
9 010 VOCABULARY									0.46	0.32	0.45	0.29	0.46
10 012 EQIV SETS:DOTS										0.37	0.31	0.27	0.40
11 013 ORDINAL NUMBER											0.43	0.34	0.45
12 014 ORDRG:GEO SHAP												0.23	0.32
13 015 CLASSIFYING													0.46

	14	15	16	17	18	19	20
1 001 GEO SHAP:NAME	0.11	0.06	0.07	0.10	0.11	0.12	-0.08
2 002 GEO SHAP:MATCH	0.22	0.13	0.07	0.26	0.17	0.19	-0.14
3 003 GEO SHAP:IDFY	0.16	0.11	0.10	0.23	0.22	0.17	-0.13
4 004 COUNT BUTTONS	0.46	0.16	0.13	0.48	0.43	0.36	-0.23
5 005 WRITE NUMERALS	0.36	0.15	0.06	0.18	0.16	0.13	-0.11
6 006 COUNT MEMS:PC	0.34	0.14	0.11	0.36	0.35	0.27	-0.16
7 007 IDFY NUMERALS	0.46	0.14	0.13	0.43	0.37	0.29	-0.21
8 008 VIS MEMRY:OBJS	0.01	0.13	0.01	0.04	0.04	0.09	-0.13
9 010 VOCABULARY	0.34	0.17	0.18	0.35	0.32	0.26	-0.19
10 012 EQIV SETS:DOTS	0.25	0.18	0.10	0.28	0.23	0.38	-0.24
11 013 ORDINAL NUMBER	0.47	0.13	0.04	0.27	0.22	0.23	-0.20
12 014 ORDRG:GEO SHAP	0.23	0.11	0.07	0.17	0.18	0.19	-0.09
13 015 CLASSIFYING	0.37	0.22	0.13	0.36	0.31	0.34	-0.26
14 016 ROTE COUNTING	0.38	0.14	0.07	0.25	0.23	0.18	-0.16
15 017 VIS MEMRY:PICT		0.11	0.06	0.10	0.10	0.15	-0.14
16 019 COLOR:MATCH			0.15	0.17	0.30	0.17	-0.13
17 020 COLOR:NAMING				0.69	0.79	0.31	-0.19
18 021 COLOR:IDFYING					0.67	0.27	-0.18
19 022 RSPNS VRBL DIR						0.47	-0.61
20 023 ATTN TO TASKS							0.40

N = 600

(CONTINUED)

Table A4.2
(second page)

	21	22	23	24	25	26	27	28	29	30
1 001 GEO SHAP:NAME	0.07	0.02	0.13	0.08	0.07	0.06	0.10	0.04	0.12	0.03
2 002 GEO SHAP:MATCH	0.26	0.20	0.18	0.13	0.28	0.23	0.18	0.26	0.28	0.19
3 003 GEO SHAP:IDFY	0.28	0.22	0.16	0.16	0.26	0.24	0.15	0.17	0.26	0.14
4 004 COUNT BUTTONS	0.30	0.21	0.30	0.34	0.41	0.40	0.43	0.42	0.56	0.42
5 005 WRITE NUMERALS	0.16	0.08	0.22	0.21	0.23	0.22	0.30	0.33	0.39	0.35
6 006 COUNT MEMS:PC	0.27	0.15	0.26	0.33	0.31	0.33	0.36	0.33	0.46	0.32
7 007 IDFY NUMERALS	0.29	0.25	0.29	0.34	0.35	0.38	0.40	0.51	0.56	0.39
8 008 VIS MEMRY:OBJS	0.07	0.06	0.01	0.06	0.01	0.07	0.06	0.00	0.05	0.05
9 010 VOCABULARY	0.43	0.24	0.27	0.24	0.47	0.42	0.28	0.36	0.43	0.28
10 012 EQIV SETS:DOTS	0.19	0.12	0.29	0.34	0.29	0.32	0.36	0.23	0.40	0.32
11 013 ORDINAL NUMBER	0.21	0.17	0.22	0.28	0.36	0.29	0.31	0.24	0.44	0.32
12 014 ORDRG:GEO SHAP	0.17	0.12	0.22	0.28	0.29	0.25	0.29	0.18	0.31	0.33
13 015 CLASSIFYING	0.30	0.21	0.27	0.28	0.41	0.38	0.35	0.26	0.47	0.32
14 016 ROTE COUNTING	0.22	0.21	0.23	0.17	0.26	0.20	0.26	0.29	0.44	0.31
15 017 VIS MEMRY:PICT	0.13	0.07	0.08	0.13	0.20	0.19	0.13	0.08	0.16	0.07
16 019 COLOR:MATCH	0.04	0.08	0.04	0.07	0.09	0.11	0.15	0.19	0.15	0.15
17 020 COLOR:NAMING	0.27	0.21	0.17	0.21	0.31	0.30	0.27	0.38	0.35	0.26
18 021 COLOR:IDFYING	0.20	0.15	0.14	0.21	0.23	0.24	0.25	0.32	0.34	0.22
19 022 RSPNS VRBL DIR	0.12	0.13	0.12	0.18	0.24	0.22	0.23	0.19	0.31	0.23
20 023 ATTN TO TASKS	-0.03	-0.05	-0.08	-0.14	-0.14	-0.13	-0.12	-0.10	-0.20	-0.19
21 M112 VOCB:WPSI SCA	0.44	0.43	0.35	0.34	0.50	0.44	0.27	0.26	0.38	0.22
22 M114 SIML:WPSI SCA		0.26	0.20	0.19	0.27	0.34	0.19	0.22	0.30	0.14
23 M117 P.CM:WPSI SCA			0.31	0.43	0.36	0.34	0.36	0.29	0.34	0.34
24 M120 BLKD:WPSI SCA				0.40	0.35	0.35	0.42	0.29	0.46	0.46
25 P201 WORD MEAN:MRT					0.51	0.58	0.41	0.37	0.53	0.36
26 P202 LISTENING:MRT						0.48	0.45	0.38	0.53	0.35
27 P203 MATCHING:MRT							0.44	0.43	0.58	0.46
28 P204 ALPHABET:MRT								0.45	0.56	0.38
29 P205 NUMBERS:MRT									0.63	0.49
30 P206 COPYING:MRT										0.41

Table A4.3
Reduced Correlation Matrix for End-of-Kindergarten Common Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 104 GEO SHAP:IDFY	0.12	0.16	0.12	0.15	0.12	0.15	0.03	-0.05	0.15	0.13	0.19	0.11	0.17
2 110 COUNT MEMS:PC		0.48	0.63	0.44	0.46	0.33	0.28	-0.24	0.34	0.21	0.20	0.19	0.33
3 111 CNT MEMS:OBJS			0.49	0.48	0.49	0.24	0.28	-0.25	0.31	0.18	0.12	0.16	0.30
4 118 EQIV SETS:OBJS				0.49	0.64	0.28	0.29	-0.20	0.34	0.19	0.14	0.24	0.33
5 119 EQIV SETS:DOTS					0.50	0.31	0.29	-0.21	0.36	0.19	0.12	0.25	0.35
6 130 CLASFY(OVRLAP)						0.32	0.21	-0.15	0.43	0.37	0.23	0.29	0.32
7 143 RSPNS VRBL DIR							0.50	-0.65	0.32	0.18	0.16	0.13	0.23
8 144 ATTN TO TASKS								0.45	-0.17	-0.08	-0.11	-0.08	-0.12
9 147 ORDRG:COMPOS									0.43	0.37	0.22	0.36	0.45
10 M112 VOCB:WPSI SCA										0.40	0.43	0.36	0.34
11 M114 SIML:WPSI SCA											0.25	0.22	0.23
12 M117 P.CM:WPSI SCA												0.31	0.45
13 M120 BLKD:WPSI SCA													0.40

	14	15	16	17	18	19
1 104 GEO SHAP:IDFY	0.22	0.20	0.12	0.26	0.18	0.10
2 110 COUNT MEMS:PC	0.33	0.31	0.35	0.34	0.47	0.38
3 111 CNT MEMS:OBJS	0.23	0.29	0.35	0.32	0.43	0.34
4 118 EQIV SETS:OBJS	0.28	0.31	0.42	0.36	0.45	0.37
5 119 EQIV SETS:DOTS	0.31	0.29	0.41	0.38	0.43	0.36
6 130 CLASFY(OVRLAP)	0.42	0.35	0.36	0.37	0.43	0.35
7 143 RSPNS VRBL DIR	0.17	0.17	0.24	0.18	0.29	0.24
8 144 ATTN TO TASKS	-0.07	-0.11	-0.22	-0.15	-0.23	-0.18
9 147 ORDRG:COMPOS	0.44	0.41	0.43	0.34	0.54	0.46
10 M112 VOCB:WPSI SCA	0.51	0.45	0.30	0.29	0.40	0.25
11 M114 SIML:WPSI SCA	0.30	0.35	0.21	0.25	0.33	0.16
12 M117 P.CM:WPSI SCA	0.37	0.35	0.37	0.32	0.37	0.36
13 M120 BLKD:WPSI SCA	0.36	0.36	0.41	0.32	0.48	0.47
14 R201 WORD MEAN:MRT	0.51	0.60	0.42	0.41	0.55	0.40
15 R202 LISTENING:MRT		0.48	0.47	0.43	0.56	0.38
16 R203 MATCHING:MRT			0.45	0.45	0.59	0.48
17 R204 ALPHABET:MRT				0.42	0.59	0.41
18 R205 NUMBERS:MRT					0.63	0.52
19 R206 COPYING:MRT						0.42

N = 671

Table A4.4

Means and Standard Deviations for Scales Used in Factor Analyses of End-of-Kindergarten Common Scales by Subpopulation

Scales	W-Pop.		X-Pop.		Y-Pop.		Z-Pop.	
	MN	SD	MN	SD	MN	SD	MN	SD
K-02 Scales								
104	4.5	0.9	4.5	0.9	4.5	0.9	4.6	0.8
110	6.5	2.8	6.7	2.8	6.5	3.0	6.6	2.9
111	7.6	2.7	7.4	2.7	7.3	2.8	7.7	2.3
118	4.5	2.0	4.3	1.9	4.2	1.9	4.6	1.8
119	4.8	1.6	4.8	1.6	4.8	1.6	5.1	1.3
130	5.4	1.1	5.4	1.1	5.3	1.3	5.3	1.2
143	3.8	0.4	3.9	0.4	3.8	0.5	3.8	0.4
144	1.3	0.7	1.3	0.7	1.4	0.9	1.3	0.6
147	5.8	3.5	5.8	3.8	6.0	3.7	5.6	3.8
WPPSI Scales								
M112	9.6	2.9	10.1	3.0	9.7	3.0	9.8	2.9
M114	10.1	2.9	10.4	2.9	10.2	2.9	10.2	2.6
M117	9.7	3.1	9.7	2.6	10.1	2.6	9.8	2.6
M120	10.5	2.6	10.6	2.8	10.5	2.6	10.8	2.6
MRT Scales								
R201	9.1	3.0	9.4	3.0	9.1	3.2	9.4	2.9
R202	10.6	2.6	10.6	2.8	10.5	2.8	10.7	2.6
R203	9.1	3.0	8.8	3.5	9.0	3.7	8.9	3.4
R204	11.7	4.2	12.0	3.9	11.8	3.9	12.3	3.8
R205	12.6	4.3	13.3	4.0	15.0	4.2	13.0	4.3
R206	5.4	2.4	5.5	2.6	5.4	2.4	5.2	2.7
(Sample Sizes)	(N = 163)		(N = 181)		(N = 162)		(N = 165)	

Table A4.5

Factor Loadings for End-of-Kindergarten Common Scales for the W-Population

Scales	Factors 1	2	3	4	5	6	7
K-02 Scales							
104					.37		
110		.62					
111		.65					
118		.63			.30		
119		.66			.32		
130							.47
143			.77				
144			-.73				
147				.44			.48
WPPSI Scales							
M112	.63						
M114	.59						
M117	.31			.53			
M120				.66			
MRT Scales							
R201	.40						.53
R202	.36					.37	.39
R203		.32		.40		.43	
R204		.38		.30	.36		
R205		.43		.48			
R206		.37		.58			
Percent of Total Variance	8	13	7	11	4	3	7

N = 163

Note: Factor loadings of less than .30 have been omitted from this table.

Table A4.6

Factor Loadings for End-of-Kindergarten Common Scales for the X-Population

Scales	Factors 1	2	3	4	5	6	7	8
<u>K-02 Scales</u>								
104				.44				
110		.72						
111		.73						
118	.30	.61						.32
119	.35	.54						.32
130	.31				.33	.39		
143			.71					
144			-.73					
147	.48	.31				.31		
<u>WPPSI Scales</u>								
M112	.34					.59		
M114						.43		
M117	.60							
M120	.62							
<u>MRT Scales</u>								
R201						.71		
R202						.60		
R203	.34	.32				.31	.34	
R204					.55	.32		
R205	.34	.36			.39	.47		
R206	.49	.36			.37			
Percent of Total Variance	11	13	7	2	5	13	1	2

N = 181

Note: Factor loadings of less than .30 have been omitted from this table.

Table A4.7

Factor Loadings for End-of-Kindergarten Common Scales for the Y-Population

Scales	Factors 1	2	3	4	5	6	7
K-02 Scales							
104							.52
110			.63				
111			.71				
118			.63				
119			.69				
130						.43	
143		.71					
144		-.70					
147	.59						
WPPSI Scales							
M112	.31			.61			
M114				.54			
M117	.48						
M120	.52		.37				
MRT Scales							
R201	.58			.38			
R202	.59			.41			
R203	.49		.39				
R204			.35		.35		.41
R205	.64		.38				
R206	.54		.32				
Percent of Total Variance	16	7	14	7	1	2	5

N = 162

Note: Factor loadings of less than .30 have been omitted from this table.

Table A4.8

Factor Loadings for End-of-Kindergarten Common Scales for the Z-Population

Scales	Factors 1	2	3	4	5	6	7
K-02 Scales							
104				.51			
110		.70					
111		.67				.32	
118						.66	
119						.67	
130	.32				.31		
143			.77				
144			-.75				
147	.34		.31		.34		
WPPSI Scales							
M112	.67						
M114	.52						
M117	.48				.37		
M120					.56		
MRT Scales							
R201	.44				.36		
R202	.57						.31
R203					.46		.50
R204							.63
R205	.39	.32					.48
R206					.61		
Percent of Total Variance	11	7	8	3	9	7	7

N = 165

Note: Factor loadings of less than .30 have been omitted from this table.

Table A4.9

Reduced Correlation Matrix for End-of-Kindergarten Common Scales for the W-Population

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	104 GEO SHAP:IDFY	0.12	0.08	0.05	0.21	0.19	0.15	0.11	-0.06	0.12	0.12	0.12	0.16	0.14
2	110 COUNT MEMS:PC		0.49	0.56	0.41	0.49	0.36	0.18	-0.18	0.42	0.25	0.19	0.26	0.24
3	111 CNT MEMS:OBJS			0.46	0.41	0.46	0.22	0.25	-0.22	0.36	0.12	0.09	0.12	0.12
4	118 EQIV SETS:OBJS				0.50	0.65	0.25	0.18	-0.09	0.32	0.15	0.27	0.22	0.19
5	119 EQIV SETS:DOTS					0.58	0.36	0.32	-0.21	0.35	0.15	0.23	0.29	0.27
6	130 CLASFY(OVRLAP)						0.39	0.03	0.04	0.46	0.34	0.25	0.32	0.30
7	143 RSPNS VRBL DIR							0.54	-0.66	0.28	0.09	0.19	0.01	0.20
8	144 ATTN TO TASKS								0.47	-0.15	-0.07	-0.08	0.03	-0.05
9	147 ORDRG:COMPOS									0.52	0.32	0.26	0.38	0.43
10	M112 VOCB:WPSI SCA										0.44	0.50	0.38	0.33
11	M114 SIML:WPSI SCA											0.35	0.30	0.20
12	M117 P.CM:WPSI SCA												0.39	0.48
13	M120 BLKD:WPSI SCA													0.43

		14	15	16	17	18	19
1	104 GEO SHAP:IDFY	0.19	0.21	0.16	0.24	0.20	0.06
2	110 COUNT MEMS:PC	0.41	0.29	0.32	0.41	0.51	0.42
3	111 CNT MEMS:OBJS	0.18	0.24	0.33	0.30	0.41	0.39
4	118 EQIV SETS:OBJS	0.29	0.26	0.38	0.37	0.44	0.29
5	119 EQIV SETS:DOTS	0.32	0.31	0.39	0.46	0.45	0.42
6	130 CLASFY(OVRLAP)	0.50	0.42	0.28	0.38	0.44	0.34
7	143 RSPNS VRBL DIR	0.07	0.10	0.08	0.13	0.17	0.16
8	144 ATTN TO TASKS	-0.01	-0.01	-0.03	-0.07	-0.10	-0.14
9	147 ORDRG:COMPOS	0.54	0.45	0.41	0.35	0.51	0.53
10	M112 VOCB:WPSI SCA	0.51	0.42	0.32	0.25	0.39	0.25
11	M114 SIML:WPSI SCA	0.32	0.36	0.24	0.28	0.32	0.17
12	M117 P.CM:WPSI SCA	0.42	0.31	0.39	0.37	0.45	0.36
13	M120 BLKD:WPSI SCA	0.34	0.30	0.37	0.31	0.48	0.49
14	P201 WORD MEAN:MRT	0.59	0.50	0.48	0.42	0.55	0.37
15	P202 LISTENING:MRT		0.40	0.51	0.39	0.52	0.39
16	P203 MATCHING:MRT			0.48	0.36	0.59	0.50
17	P204 ALPHABET:MRT				0.41	0.55	0.41
18	P205 NUMBERS:MRT					0.63	0.57
19	P206 COPYING:MRT						0.51

N = 163

Table A4.10

Reduced Correlation Matrix for End-of-Kindergarten Common Scales for the X-Population

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 104 GEO SHAP:IDFY	0.19	0.12	0.18	0.11	0.06	0.04	-0.05	-0.01	0.10	0.14	0.18	0.15	0.14
2 110 COUNT MEMS:PC		0.52	0.66	0.49	0.42	0.35	0.20	-0.19	0.36	0.20	0.14	0.22	0.35
3 111 CNT MEMS:OBJS			0.53	0.51	0.45	0.35	0.23	-0.18	0.34	0.24	0.15	0.20	0.34
4 118 EQIV SETS:OBJS				0.55	0.64	0.38	0.26	-0.14	0.48	0.28	0.05	0.29	0.38
5 119 EQIV SETS:DOTS					0.52	0.44	0.11	-0.05	0.45	0.29	0.08	0.35	0.43
6 130 CLASFY(OVRLAP)						0.46	0.30	-0.21	0.46	0.41	0.20	0.42	0.35
7 143 RSPNS VRBL DIR							0.48	-0.62	0.29	0.21	0.17	0.13	0.14
8 144 ATTN TO TASKS								0.47	-0.13	-0.10	-0.18	-0.05	-0.04
9 147 ORDRG:COMPOS									0.52	0.38	0.23	0.41	0.52
10 M112 VOCB:WPSI SCA										0.43	0.38	0.38	0.40
11 M114 SIML:WPSI SCA											0.26	0.18	0.21
12 M117 P.CM:WPSI SCA												0.41	0.53
13 M120 BLKD:WPSI SCA													0.46

	14	15	16	17	18	19
1 104 GEO SHAP:IDFY	0.30	0.25	0.09	0.25	0.23	0.14
2 110 COUNT MEMS:PC	0.27	0.29	0.40	0.25	0.43	0.44
3 111 CNT MEMS:OBJS	0.27	0.27	0.32	0.31	0.47	0.40
4 118 EQIV SETS:OBJS	0.26	0.29	0.43	0.29	0.45	0.45
5 119 EQIV SETS:DOTS	0.32	0.29	0.42	0.36	0.46	0.45
6 130 CLASFY(OVRLAP)	0.46	0.44	0.40	0.47	0.52	0.44
7 143 RSPNS VRBL DIR	0.17	0.20	0.21	0.17	0.26	0.17
8 144 ATTN TO TASKS	-0.01	-0.18	-0.21	-0.11	-0.26	-0.13
9 147 ORDRG:COMPOS	0.44	0.37	0.45	0.38	0.61	0.51
10 M112 VOCB:WPSI SCA	0.55	0.44	0.36	0.31	0.47	0.36
11 M114 SIML:WPSI SCA	0.34	0.35	0.25	0.27	0.37	0.30
12 M117 P.CM:WPSI SCA	0.35	0.37	0.37	0.34	0.43	0.49
13 M120 BLKD:WPSI SCA	0.31	0.34	0.41	0.33	0.49	0.48
14 P201 WORD MEAN:MRT	0.57	0.61	0.36	0.45	0.56	0.38
15 P202 LISTENING:MRT		0.50	0.47	0.41	0.57	0.41
16 P203 MATCHING:MRT			0.47	0.42	0.61	0.51
17 P204 ALPHABET:MRT				0.49	0.61	0.55
18 P205 NUMBERS:MRT					0.69	0.57
19 P206 COPYING:MRT						0.54

N = 181

Table A4.11

Reduced Correlation Matrix for End-of-Kindergarten Common Scales for the Y-Population

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 104 GEO SHAP:IDFY	0.25	0.28	0.12	0.22	0.10	0.21	0.03	-0.06	0.15	0.12	0.24	-0.03	0.17
2 110 COUNT MEMS:PC		0.58	0.66	0.50	0.57	0.38	0.34	-0.27	0.33	0.24	0.28	0.25	0.47
3 111 CNT MEMS:OBJS			0.57	0.53	0.59	0.22	0.32	-0.31	0.29	0.20	0.15	0.22	0.46
4 118 EQIV SETS:OBJS				0.54	0.65	0.23	0.34	-0.24	0.28	0.16	0.16	0.20	0.39
5 119 EQIV SETS:DOTS					0.58	0.30	0.38	-0.29	0.35	0.16	0.16	0.26	0.48
6 130 CLASFY(OVRLAP)						0.32	0.23	-0.12	0.40	0.34	0.18	0.17	0.29
7 143 RSPNS VRBL DIR							0.50	-0.63	0.23	0.10	0.13	0.20	0.35
8 144 ATTN TO TASKS								0.45	-	0.04	-0.04	-0.15	-0.20
9 147 CPDRG:COMPOS										0.35	0.16	0.32	0.45
10 M112 VOCB:WPSI SCA										0.45	0.41	0.23	0.32
11 M114 SIML:WPSI SCA											0.30	0.12	0.27
12 M117 P.CM:WPSI SCA												0.26	0.38
13 M120 BLKD:WPSI SCA													0.50

	14	15	16	17	18	19
1 104 GEO SHAP:IDFY	0.24	0.28	0.17	0.33	0.23	0.08
2 110 COUNT MEMS:PC	0.42	0.43	0.47	0.41	0.54	0.40
3 111 CNT MEMS:OBJS	0.27	0.40	0.44	0.36	0.48	0.37
4 118 EQIV SETS:OBJS	0.32	0.38	0.47	0.47	0.50	0.44
5 119 EQIV SETS:DOTS	0.36	0.39	0.51	0.40	0.54	0.39
6 130 CLASFY(OVRLAP)	0.40	0.30	0.35	0.34	0.40	0.30
7 143 RSPNS VRBL DIR	0.23	0.13	0.33	0.20	0.35	0.30
8 144 ATTN TO TASKS	-0.09	-0.07	-0.30	-0.15	-0.25	-0.21
9 147 CPDRG:COMPOS	0.41	0.48	0.44	0.29	0.54	0.44
10 M112 VOCB:WPSI SCA	0.53	0.47	0.19	0.26	0.36	0.16
11 M114 SIML:WPSI SCA	0.25	0.37	0.20	0.23	0.28	0.06
12 M117 P.CM:WPSI SCA	0.38	0.37	0.32	0.19	0.36	0.28
13 M120 BLKD:WPSI SCA	0.46	0.51	0.39	0.29	0.59	0.44
14 P201 WORD MEAN:MRT	0.60	0.64	0.44	0.34	0.61	0.39
15 P202 LISTENING:MRT		0.61	0.49	0.45	0.62	0.39
16 P203 MATCHING:MRT			0.50	0.44	0.62	0.45
17 P204 ALPHABET:MRT				0.47	0.60	0.34
18 P205 NUMBERS:MRT					0.71	0.55
19 P206 COPYING:MRT						0.41

N = 162

Table A4.12
Reduced Correlation Matrix for End-of-Kindergarten Common Scales for the Z-Population

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 104 GEO SHAP:IDFY	0.22	0.15	0.12	0.07	0.14	0.19	0.06	-0.08	0.23	0.15	0.25	0.18	0.23
2 110 COUNT MEMS:PC		0.51	0.66	0.37	0.34	0.23	0.36	-0.32	0.29	0.16	0.16	0.05	0.25
3 111 CNT MEMS:OBJS			0.52	0.47	0.43	0.17	0.34	-0.29	0.25	0.14	0.11	0.09	0.29
4 118 EQIV SETS:OBJS				0.56	0.64	0.17	0.40	-0.35	0.26	0.20	0.08	0.26	0.34
5 119 EQIV SETS:DOTS					0.51	0.10	0.39	-0.32	0.27	0.07	0.02	0.06	0.17
6 130 CLASFY(OVRLAP)						0.34	0.24	-0.29	0.41	0.40	0.29	0.28	0.34
7 143 PSPNS VRBL DIR							0.66	-0.73	0.47	0.30	0.18	0.18	0.25
8 144 ATTN TO TASKS								0.60	-0.33	-0.23	-0.17	-0.16	-0.16
9 147 ORDRG:COMPOS									0.47	0.41	0.25	0.32	0.38
10 M112 VOCB:WPSI SCA										0.46	0.41	0.46	0.29
11 M114 SIML:WPSI SCA											0.31	0.28	0.22
12 M117 P.CM:WPSI SCA												0.40	0.41
13 M120 BLKD:WPSI SCA													0.41

	14	15	16	17	18	19
1 104 GEO SHAP:IDFY	0.12	0.05	0.07	0.21	0.05	0.11
2 110 COUNT MEMS:PC	0.20	0.24	0.21	0.29	0.41	0.25
3 111 CNT MEMS:OBJS	0.20	0.21	0.28	0.32	0.37	0.21
4 118 EQIV SETS:OBJS	0.25	0.31	0.39	0.32	0.41	0.31
5 119 EQIV SETS:DOTS	0.19	0.15	0.30	0.27	0.27	0.18
6 130 CLASFY(OVRLAP)	0.33	0.24	0.37	0.32	0.36	0.33
7 143 PSPNS VRBL DIR	0.19	0.24	0.32	0.21	0.35	0.31
8 144 ATTN TO TASKS	-0.18	-0.18	-0.28	-0.31	-0.31	-0.24
9 147 ORDRG:COMPOS	0.37	0.36	0.42	0.34	0.50	0.36
10 M112 VOCB:WPSI SCA	0.42	0.48	0.35	0.35	0.39	0.20
11 M114 SIML:WPSI SCA	0.26	0.32	0.17	0.21	0.35	0.10
12 M117 P.CM:WPSI SCA	0.34	0.39	0.39	0.35	0.23	0.30
13 M120 BLKD:WPSI SCA	0.31	0.30	0.45	0.35	0.39	0.47
14 P201 WORD MEAN:MRT	0.44	0.53	0.43	0.41	0.47	0.46
15 P202 LISTENING:MRT		0.49	0.43	0.48	0.53	0.35
16 P203 MATCHING:MRT			0.55	0.60	0.57	0.46
17 P204 ALPHABET:MRT				0.56	0.59	0.36
18 P205 NUMBERS:MRT					0.62	0.41
19 P206 COPYING:MRT						0.42

N = 165

Table A4.13

Reduced Correlation Matrix for End-of-Kindergarten Scales for the W-Population

		1	2	3	4	5	6	7	8	9	10	11	12
1	114W VIS MEMRY:OBJ	0.16	0.14	0.15	0.04	-0.02	-0.04	-0.02	-0.08	0.00	0.07	-0.18	0.05
2	133W VIS MEMRY:PC		0.21	0.32	0.10	0.15	0.08	0.15	0.13	0.08	0.15	-0.04	0.19
3	135W VIS MMRY:SHAP			0.18	0.11	0.07	0.01	0.12	0.14	0.02	0.19	-0.11	0.15
4	104 GEO SHAP:IDFY				0.12	0.08	0.05	0.21	0.19	0.15	0.11	-0.06	0.12
5	110 COUNT MEMS:PC					0.49	0.56	0.41	0.49	0.36	0.18	-0.18	0.42
6	111 CNT MEMS:OBJS						0.47	0.41	0.46	0.22	0.25	-0.22	0.36
7	118 EQIV SETS:OBJS							0.50	0.65	0.25	0.18	-0.09	0.32
8	119 EQIV SETS:DOTS								0.59	0.36	0.32	-0.21	0.35
9	130 CLASFY(OVPLAP)									0.39	0.03	0.04	0.46
10	143 RSPNS VRBL DIR										0.55	-0.66	0.28
11	144 ATTN TO TASKS											0.50	-0.15
12	147 OF ORG:COMPOS												0.53

		13	14	15	16	17	18	19	20	21	22
1	114W VIS MEMRY:OBJ	0.10	0.00	0.03	0.10	0.05	0.16	0.12	0.03	0.09	0.01
2	133W VIS MEMRY:PC	0.15	0.19	0.12	0.04	0.24	0.13	0.07	0.07	0.14	0.11
3	135W VIS MMRY:SHAP	0.06	0.09	0.12	0.05	0.12	0.08	0.05	0.14	0.13	0.01
4	104 GEO SHAP:IDFY	0.12	0.12	0.16	0.14	0.19	0.21	0.16	0.24	0.20	0.06
5	110 COUNT MEMS:PC	0.25	0.19	0.26	0.24	0.41	0.29	0.32	0.41	0.51	0.42
6	111 CNT MEMS:OBJS	0.12	0.09	0.12	0.12	0.18	0.26	0.33	0.30	0.41	0.39
7	118 EQIV SETS:OBJS	0.15	0.27	0.22	0.19	0.29	0.26	0.36	0.37	0.44	0.29
8	119 EQIV SETS:DOTS	0.15	0.23	0.29	0.27	0.32	0.31	0.39	0.46	0.45	0.42
9	130 CLASFY(OVPLAP)	0.34	0.25	0.32	0.30	0.50	0.42	0.28	0.38	0.44	0.34
10	143 RSPNS VRBL DIR	0.09	0.19	0.31	0.20	0.07	0.10	0.08	0.13	0.17	0.16
11	144 ATTN TO TASKS	-0.07	-0.08	0.03	-0.05	-0.01	-0.01	-0.03	-0.07	-0.10	-0.14
12	147 OF ORG:COMPOS	0.32	0.26	0.38	0.43	0.54	0.45	0.41	0.35	0.51	0.53
13	M112 VOCB:WPSI SCA	0.44	0.50	0.38	0.33	0.51	0.42	0.32	0.25	0.39	0.25
14	M114 SIML:WPSI SCA		0.35	0.30	0.27	0.32	0.36	0.24	0.28	0.32	0.17
15	M117 P.CM:WPSI SCA			0.40	0.48	0.42	0.31	0.39	0.37	0.45	0.36
16	M120 BLKD:WPSI SCA				0.44	0.34	0.30	0.37	0.31	0.48	0.49
17	P201 WORD MEAN:MRT					0.61	0.59	0.48	0.42	0.55	0.37
18	P202 LISTENING:MRT						0.50	0.51	0.39	0.52	0.39
19	P203 MATCHING:MRT							0.49	0.36	0.59	0.50
20	P204 ALPHABET:MRT								0.42	0.55	0.41
21	P205 NUMBERS:MRT									0.63	0.57
22	P206 COPYING:MRT										0.53

N = 163

Table A4.14
Reduced Correlation Matrix for End-of-Kindergarten Scales for the X-Population

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 106X COUNT BUTNS	0.60	0.42	0.66	0.46	0.20	0.48	0.49	0.42	0.49	0.40	0.24	-0.24	0.39
2 108X WRITE NUMERAL		0.38	0.55	0.18	0.18	0.18	0.23	0.18	0.17	0.18	0.09	-0.09	0.17
3 113X IDFY NUMERALS			0.62	0.40	0.30	0.36	0.45	0.36	0.39	0.38	0.14	-0.13	0.38
4 117X VOCABULARY				0.54	0.14	0.27	0.31	0.31	0.47	0.49	0.28	-0.21	0.49
5 104 GEO SHAP:IDFY					0.22	0.12	0.19	0.09	0.07	0.04	-0.05	0.00	0.09
6 110 COUNT MEMS:PC						0.53	0.67	0.49	0.42	0.36	0.20	-0.18	0.35
7 111 CNT MEMS:OBJS							0.56	0.53	0.45	0.35	0.23	-0.18	0.34
8 118 EQIV SETS:OBJS								0.57	0.65	0.39	0.27	-0.13	0.47
9 119 EQIV SETS:DOTS									0.58	0.44	0.11	-0.05	0.46
10 130 CLASFY(OVRLAP)										0.47	0.30	-0.22	0.47
11 143 RSPNS VRBL DIR											0.49	-0.63	0.29
12 144 ATTN TO TASKS												0.47	-0.12
13 147 ORDRG:COMPOS													0.54

	14	15	16	17	18	19	20	21	22	23
1 106X COUNT BUTNS	0.29	0.24	0.27	0.42	0.33	0.40	0.47	0.47	0.58	0.38
2 108X WRITE NUMERAL	0.14	0.17	0.20	0.18	0.21	0.24	0.27	0.44	0.42	0.34
3 113X IDFY NUMERALS	0.27	0.14	0.29	0.32	0.37	0.43	0.42	0.58	0.57	0.46
4 117X VOCABULARY	0.52	0.27	0.34	0.40	0.52	0.51	0.41	0.38	0.57	0.34
5 104 GEO SHAP:IDFY	0.13	0.17	0.16	0.15	0.30	0.24	0.07	0.25	0.22	0.13
6 110 COUNT MEMS:PC	0.20	0.14	0.23	0.36	0.27	0.29	0.40	0.25	0.43	0.44
7 111 CNT MEMS:OBJS	0.24	0.15	0.20	0.34	0.27	0.27	0.33	0.31	0.48	0.40
8 118 EQIV SETS:OBJS	0.27	0.05	0.30	0.41	0.26	0.29	0.42	0.29	0.44	0.45
9 119 EQIV SETS:DOTS	0.29	0.08	0.35	0.43	0.32	0.29	0.43	0.36	0.46	0.45
10 130 CLASFY(OVRLAP)	0.41	0.20	0.42	0.35	0.46	0.44	0.42	0.47	0.53	0.44
11 143 RSPNS VRBL DIR	0.22	0.17	0.13	0.14	0.17	0.20	0.21	0.17	0.27	0.17
12 144 ATTN TO TASKS	-0.09	-0.18	-0.05	-0.05	-0.01	-0.18	-0.20	-0.11	-0.25	-0.13
13 147 ORDRG:COMPOS	0.38	0.23	0.42	0.54	0.44	0.37	0.45	0.38	0.60	0.51
14 M112 VOCB:WPSI SCA	0.46	0.38	0.39	0.41	0.55	0.44	0.36	0.31	0.47	0.36
15 M114 SIML:WPSI SCA		0.29	0.18	0.21	0.34	0.35	0.24	0.27	0.37	0.30
16 M117 P.CM:WPSI SCA			0.42	0.53	0.35	0.37	0.39	0.34	0.44	0.49
17 M120 BLKD:WPSI SCA				0.48	0.32	0.34	0.43	0.33	0.50	0.49
18 R201 WORD MEAN:MRT					0.58	0.61	0.36	0.45	0.56	0.38
19 R202 LISTENING:MRT						0.52	0.47	0.42	0.57	0.41
20 R203 MATCHING:MRT							0.47	0.43	0.60	0.52
21 R204 ALPHABET:MRT								0.54	0.61	0.55
22 R205 NUMBERS:MRT									0.71	0.58
23 R206 COPYING:MRT										0.57

Table A4.15
Reduced Correlation Matrix for End-of-Kindergarten Scales for the Y-Population

	1	2	3	4	5	6	7	8	9	10	11	12
1 102Y GEOSHAP:NAME	0.44	0.21	0.42	0.48	0.23	0.18	0.29	0.21	0.36	0.04	-0.01	0.13
2 120Y ORDNAL NUMBER		0.53	0.38	0.20	0.50	0.47	0.46	0.46	0.39	0.25	-0.16	0.47
3 128Y CLASSFYING-SI			0.49	0.37	0.40	0.34	0.30	0.38	0.52	0.29	-0.21	0.35
4 104 GEO SHAP:IDFY				0.39	0.28	0.12	0.22	0.10	0.21	0.33	-0.06	0.15
5 110 COUNT MEMS:PC					0.59	0.66	0.50	0.57	0.38	0.34	-0.27	0.33
6 111 CNT MEMS:OBJS						0.58	0.53	0.59	0.22	0.32	-0.31	0.29
7 118 EQIV SETS:OBJS							0.55	0.65	0.33	0.34	-0.24	0.28
8 119 EQIV SETS:DOTS								0.58	0.30	0.38	-0.29	0.35
9 130 CLASFY(OVRLAP)									0.42	0.23	-0.12	0.40
10 143 RSPNS VRBL DIR										0.51	-0.63	0.23
11 144 ATTN TO TASKS											0.45	-0.13
12 147 ORDRG:COMPOS												0.44

	13	14	15	16	17	18	19	20	21	22
1 102Y GEOSHAP:NAME	0.27	0.33	0.12	0.21	0.31	0.21	0.22	0.39	0.29	0.08
2 120Y ORDNAL NUMBER	0.39	0.22	0.21	0.52	0.49	0.49	0.47	0.43	0.62	0.48
3 128Y CLASSFYING-SI	0.30	0.30	0.26	0.38	0.38	0.33	0.30	0.42	0.48	0.34
4 104 GEO SHAP:IDFY	0.12	0.24	-0.03	0.17	0.24	0.28	0.17	0.33	0.23	0.08
5 110 COUNT MEMS:PC	0.24	0.28	0.25	0.47	0.42	0.43	0.47	0.41	0.54	0.40
6 111 CNT MEMS:OBJS	0.20	0.15	0.22	0.46	0.27	0.40	0.44	0.36	0.48	0.37
7 118 EQIV SETS:OBJS	0.16	0.16	0.20	0.39	0.32	0.38	0.47	0.47	0.50	0.44
8 119 EQIV SETS:DOTS	0.15	0.16	0.26	0.48	0.36	0.39	0.51	0.40	0.54	0.39
9 130 CLASFY(OVRLAP)	0.34	0.18	0.17	0.29	0.40	0.30	0.35	0.34	0.40	0.30
10 143 RSPNS VRBL DIR	0.10	0.13	0.20	0.35	0.23	0.13	0.33	0.20	0.35	0.30
11 144 ATTN TO TASKS	0.04	-0.04	-0.15	-0.20	-0.09	-0.07	-0.30	-0.15	-0.25	-0.21
12 147 ORDRG:COMPOS	0.35	0.16	0.32	0.45	0.41	0.48	0.44	0.29	0.54	0.44
13 M112 VOCB:WPSI SCA	0.46	0.41	0.23	0.32	0.53	0.47	0.19	0.26	0.36	0.16
14 M114 SIML:WPSI SCA		0.34	0.12	0.27	0.25	0.37	0.20	0.23	0.28	0.06
15 M117 P.CM:WPSI SCA			0.29	0.38	0.38	0.37	0.32	0.19	0.36	0.28
16 M120 BLKD:WPSI SCA				0.52	0.46	0.51	0.39	0.29	0.59	0.44
17 R201 WORD MEAN:MRT					0.62	0.64	0.44	0.34	0.61	0.39
18 R202 LISTENING:MRT						0.63	0.49	0.45	0.62	0.39
19 R203 MATCHING:MRT							0.51	0.44	0.62	0.45
20 R204 ALPHABET:MRT								0.50	0.60	0.34
21 R205 NUMBERS:MRT									0.71	0.55
22 R206 COPYING:MRT										0.43

Table A4.16

Reduced Correlation Matrix for End-of-Kindergarten Scales for the Z-Population

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 131Z VIS MEMRY:PIC	0.22	0.23	0.24	0.19	0.06	0.13	0.12	0.10	0.15	0.13	0.32	-0.31	0.23
2 137Z ORDRG:SET OBJ		0.76	0.85	0.54	0.16	0.39	0.28	0.28	0.28	0.35	0.48	-0.36	0.62
3 139Z ORDR:PICT SET			0.80	0.53	0.22	0.38	0.32	0.34	0.27	0.39	0.49	-0.36	0.70
4 146Z CNSRVATN CMPO				0.50	0.19	0.39	0.41	0.39	0.35	0.30	0.33	-0.28	0.52
5 104 GEO SHAP:IDFY					0.24	0.16	0.14	0.08	0.16	0.20	0.08	-0.10	0.24
6 110 COUNT MEMS:PC						0.52	0.65	0.35	0.31	0.20	0.34	-0.29	0.28
7 111 CNT MEMS:OBJS							0.52	0.44	0.38	0.12	0.29	-0.23	0.23
8 118 EQIV SETS:OBJS								0.57	0.62	0.13	0.36	-0.31	0.25
9 119 EQIV SETS:DOTS									0.51	0.04	0.32	-0.24	0.25
10 130 CLASFY(OVRLAP)										0.33	0.18	-0.24	0.39
11 143 RSPNS VRBL DIR											0.65	-0.70	0.46
12 144 ATTN TO TASKS												0.57	-0.31
13 147 ORDRG:COMPOS													0.61

	14	15	16	17	18	19	20	21	22	23
1 131Z VIS MEMRY:PIC	0.19	0.11	-0.02	0.05	0.08	0.05	0.27	0.15	0.21	0.07
2 137Z ORDRG:SET OBJ	0.33	0.24	0.20	0.36	0.29	0.30	0.41	0.35	0.52	0.37
3 139Z ORDR:PICT SET	0.36	0.25	0.28	0.41	0.26	0.32	0.39	0.40	0.52	0.42
4 146Z CNSRVATN CMPO	0.32	0.20	0.25	0.41	0.38	0.38	0.43	0.32	0.51	0.38
5 104 GEO SHAP:IDFY	0.16	0.25	0.19	0.24	0.13	0.06	0.07	0.23	0.06	0.11
6 110 COUNT MEMS:PC	0.14	0.15	0.03	0.24	0.18	0.22	0.20	0.27	0.40	0.24
7 111 CNT MEMS:OBJS	0.10	0.09	0.06	0.27	0.17	0.18	0.26	0.29	0.34	0.18
8 118 EQIV SETS:OBJS	0.17	0.06	0.24	0.33	0.22	0.28	0.38	0.29	0.39	0.29
9 119 EQIV SETS:DOTS	0.03	-0.01	0.02	0.14	0.14	0.10	0.28	0.23	0.22	0.14
10 130 CLASFY(OVRLAP)	0.38	0.28	0.26	0.32	0.31	0.21	0.36	0.29	0.33	0.31
11 143 RSPNS VRBL DIR	0.26	0.16	0.14	0.23	0.14	0.20	0.30	0.16	0.31	0.28
12 144 ATTN TO TASKS	-0.19	-0.14	-0.12	-0.13	-0.13	-0.13	-0.26	-0.27	-0.27	-0.21
13 147 ORDRG:COMPOS	0.40	0.24	0.31	0.37	0.35	0.35	0.41	0.32	0.49	0.35
14 M112 VOCB:WPSI SCA	0.46	0.41	0.45	0.28	0.41	0.47	0.34	0.33	0.37	0.18
15 M114 SIML:WPSI SCA		0.31	0.27	0.21	0.25	0.31	0.16	0.20	0.34	0.09
16 M117 P.CM:WPSI SCA			0.42	0.40	0.32	0.37	0.36	0.33	0.21	0.29
17 M120 BLKD:WPSI SCA				0.41	0.30	0.28	0.45	0.34	0.38	0.47
18 R201 WORD MEAN:MRT					0.44	0.52	0.42	0.40	0.45	0.44
19 R202 LISTENING:MRT						0.49	0.42	0.47	0.51	0.33
20 R203 MATCHING:MRT							0.59	0.59	0.56	0.45
21 R204 ALPHABET:MRT								0.57	0.58	0.34
22 R205 NUMBERS:MRT									0.63	0.39
23 R206 COPYING:MRT										0.43

N = 164

APPENDIX 5

Auxiliary Tables for Chapter 5

Table A5.1
Reduced Correlation Matrix for End-of-First-Grade Scales
Original Students Only

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 306 PLACE VALUE	0.50	0.46	0.44	0.55	0.17	0.53	0.52	0.41	0.21	-0.20	0.11	0.30	-0.05
2 307 NUMBER CMPARSN		0.35	0.39	0.45	0.12	0.40	0.40	0.28	0.16	-0.18	0.16	0.29	-0.11
3 308 NUMBER LINE			0.36	0.38	0.18	0.42	0.42	0.27	0.24	-0.21	0.12	0.23	0.01
4 309 APPLICATION				0.48	0.14	0.49	0.52	0.38	0.15	-0.18	0.13	0.23	-0.01
5 310 RATIONALS					0.08	0.12	0.17	0.09	0.10	-0.01	0.04	0.12	0.05
6 311 COMPUTE:ADD						0.51	0.64	0.36	0.23	-0.16	0.08	0.20	-0.02
7 312 COMPUTE:SUBT							0.55	0.40	0.22	-0.23	0.01	0.21	-0.00
8 313 COMPUTE:MULT								0.30	0.14	-0.15	0.09	0.16	0.06
9 317 RESP VERB DIR									0.30	-0.47	0.15	0.17	-0.07
10 318 ATTN TO TASKS										0.30	0.00	-0.09	0.02
11 321 IDFY TRIANGS											0.33	0.45	-0.40
12 322 IDFY RECTS												0.35	-0.36
13 323 CURVD FIGS													0.24

	14	15	16	17	18	19	20	21
1 306 PLACE VALUE	0.39	0.42	0.45	0.47	0.51	0.32	0.38	0.36
2 307 NUMBER CMPARSN	0.33	0.33	0.40	0.39	0.45	0.25	0.31	0.32
3 308 NUMBER LINE	0.35	0.36	0.40	0.40	0.44	0.30	0.35	0.37
4 309 APPLICATION	0.46	0.39	0.41	0.43	0.46	0.31	0.39	0.38
5 310 RATIONALS	0.14	0.16	0.13	0.15	0.17	0.11	0.13	0.15
6 311 COMPUTE:ADD	0.35	0.43	0.48	0.46	0.47	0.30	0.30	0.31
7 312 COMPUTE:SUBT	0.38	0.51	0.52	0.52	0.47	0.24	0.33	0.29
8 313 COMPUTE:MULT	0.40	0.34	0.40	0.40	0.33	0.22	0.27	0.24
9 317 RESP VERB DIR	0.13	0.30	0.19	0.20	0.26	0.17	0.06	0.12
10 318 ATTN TO TASKS	-0.16	-0.33	-0.22	-0.23	-0.23	-0.18	-0.11	-0.19
11 321 IDFY TRIANGS	0.22	0.03	0.11	0.08	0.13	0.07	0.07	0.13
12 322 IDFY RECTS	0.23	0.23	0.31	0.27	0.27	0.17	0.22	0.21
13 323 CURVD FIGS	-0.01	-0.01	-0.01	0.01	-0.02	-0.01	-0.01	-0.00
14 328 CMPREHEN:GROUP	0.35	0.34	0.36	0.34	0.34	0.20	0.29	0.22
15 329 CMPREHEN:INDIV		0.38	0.42	0.41	0.40	0.24	0.27	0.28
16 A201 #PT:SAT WORD			0.74	0.84	0.55	0.29	0.32	0.29
17 A205 #PT:SAT PGPH				0.73	0.54	0.25	0.26	0.23
18 M324 IQ:KUHL-ANDER					0.49	0.38	0.44	0.37
19 M201 SET A:RAVEN						0.31	0.49	0.38
20 M202 SET AB:RAVEN							0.47	0.57
21 M203 SET B:RAVEN								0.40

N = [illegible]

Table A5.2
Reduced Correlation Matrix for End-of-First-Grade Scales Excluding the Raven Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 306 PLACE VALUE	0.48	0.48	0.43	0.55	0.15	0.52	0.52	0.36	0.19	-0.16	0.15	0.30	-0.04
2 307 NUMBER CMPARSN		0.38	0.40	0.46	0.09	0.42	0.42	0.25	0.16	-0.15	0.18	0.29	-0.09
3 308 NUMBER LINE			0.33	0.38	0.14	0.41	0.45	0.28	0.16	-0.15	0.11	0.25	-0.00
4 309 APPLICATION				0.44	0.14	0.47	0.49	0.34	0.13	-0.15	0.13	0.24	-0.01
5 310 RATIONALS					0.05	0.11	0.12	0.08	0.06	-0.01	0.02	0.10	0.02
6 311 COMPUTE:ADD						0.50	0.64	0.31	0.17	-0.15	0.10	0.22	-0.04
7 312 COMPUTE:SUBT							0.56	0.37	0.16	-0.20	0.05	0.23	-0.02
8 313 COMPUTE:MULT								0.25	0.11	-0.13	0.10	0.17	0.02
9 317 RESP VERB DIR									0.35	-0.57	0.09	0.13	-0.02
10 318 ATTN TO TASKS										0.36	0.03	-0.05	-0.02
11 321 IDFY TRIANGS											0.29	0.42	-0.43
12 322 IDFY RECTS												0.34	-0.41
13 323 CURVD FIGS													0.28

	14	15	16	17	18
1 306 PLACE VALUE	0.40	0.41	0.45	0.45	0.50
2 307 NUMBER CMPARSN	0.34	0.38	0.41	0.39	0.48
3 308 NUMBER LINE	0.31	0.37	0.40	0.40	0.44
4 309 APPLICATION	0.44	0.37	0.38	0.39	0.45
5 310 RATIONALS	0.13	0.11	0.09	0.11	0.11
6 311 COMPUTE:ADD	0.31	0.45	0.47	0.45	0.46
7 312 COMPUTE:SUBT	0.34	0.51	0.52	0.52	0.49
8 313 COMPUTE:MULT	0.34	0.31	0.38	0.39	0.31
9 317 RESP VERB DIR	0.12	0.25	0.16	0.16	0.22
10 318 ATTN TO TASKS	-0.12	-0.28	-0.17	-0.19	-0.19
11 321 IDFY TRIANGS	0.19	0.09	0.11	0.10	0.13
12 322 IDFY RECTS	0.21	0.21	0.28	0.26	0.28
13 323 CURVD FIGS	-0.02	-0.01	-0.02	-0.01	-0.05
14 328 CMPREHEN:GROUP	0.29	0.30	0.32	0.34	0.34
15 329 CMPREHEN:INDIV		0.37	0.41	0.42	0.41
16 A201 #RT:SAT WORD			0.72	0.83	0.52
17 A205 #RT:SAT PGPH				0.72	0.52
18 M324 IQ:KUHL-ANDER					0.45

N = 964

Table A5.3

Means and Standard Deviations for Scales Used in Factor Analysis of End-of-First-Grade Scales Excluding the Raven Scales
Original Students Only

Scales	MN	SD
Math Scales		
306	4.44	2.05
307	5.22	1.50
308	3.26	1.29
309	4.16	1.67
310	2.88	1.32
311	7.05	2.27
312	4.85	3.13
313	0.36	0.69
317	3.93	0.26
318	1.2[illegible]	0.53
321	4.69	1.84
322	2.68	1.43
323	3.41	1.46
328	1.77	1.08
329	2.29	1.27
SAT Scales		
A201	20.63	7.76
A205	20.24	9.56
Kuhlmann-Anderson		
M324	109.03	14.69

N = 564

Table A5.4

Factor Loadings for End-of-First-Grade Scales Excluding the Raven Scales
Original Students Only

Scales	Factors 1	2	3	4	5
Math Scales					
306	.65				
307	.53				
308	.47				
309	.66				
310					
311	.69				
312	.69				
313	.42				.36
317			.59		
318			-.60		
321		.63			
322		.58			
323		-.58			
328	.42				.40
329	.48		.36		
SAT Scales					
A201	.41			.76	
A205	.41			.75	
Kuhlmann-Anderson					
M324	.58			.35	
Percent of Total Variance	20	7	6	9	2

N = 564

Note: Factor loadings of less than .30 have been omitted from this table.

Table A5.5
Reduced Correlation Matrix for End-of-First-Grade Scales Excluding the Raven Scales
Original Students Only

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 306 PLACE VALUE	0.49	0.47	0.45	0.56	0.18	0.53	0.52	0.41	0.22	-0.20	0.11	0.30	-0.07
2 307 NUMBER CMPARSN		0.36	0.40	0.46	0.12	0.41	0.42	0.29	0.17	-0.19	0.16	0.28	-0.12
3 308 NUMBER LINE			0.35	0.39	0.19	0.43	0.43	0.28	0.24	-0.21	0.11	0.24	0.01
4 309 APPLICATION				0.47	0.15	0.50	0.53	0.39	0.15	-0.19	0.11	0.23	-0.01
5 310 RATIONALS					0.07	0.11	0.17	0.10	0.09	-0.00	0.03	0.10	0.05
6 311 COMPUTE:ADD						0.51	0.64	0.36	0.24	-0.17	0.07	0.21	-0.02
7 312 COMPUTE:SUBT							0.55	0.41	0.22	-0.24	0.01	0.21	-0.01
8 313 COMPUTE:MULT								0.31	0.13	-0.15	0.07	0.16	0.06
9 317 RESP VERB DIR									0.29	-0.47	0.14	0.16	-0.07
10 318 ATTN TO TASKS										0.29	0.00	-0.07	0.02
11 321 IDFY TRIANGS											0.31	0.43	-0.40
12 322 IDFY RECTS												0.34	-0.37
13 323 CURVD FIGS													0.25

	14	15	16	17	18
1 306 PLACE VALUE	0.39	0.43	0.45	0.46	0.51
2 307 NUMBER CMPARSN	0.34	0.35	0.42	0.40	0.45
3 308 NUMBER LINE	0.36	0.38	0.41	0.41	0.44
4 309 APPLICATION	0.46	0.40	0.42	0.44	0.45
5 310 RATIONALS	0.15	0.16	0.12	0.15	0.17
6 311 COMPUTE:ADD	0.34	0.45	0.48	0.46	0.47
7 312 COMPUTE:SUBT	0.37	0.52	0.52	0.52	0.47
8 313 COMPUTE:MULT	0.42	0.34	0.41	0.41	0.32
9 317 RESP VERB DIR	0.13	0.30	0.20	0.20	0.27
10 318 ATTN TO TASKS	-0.16	-0.33	-0.21	-0.23	-0.24
11 321 IDFY TRIANGS	0.21	0.03	0.10	0.07	0.12
12 322 IDFY RECTS	0.22	0.22	0.30	0.27	0.25
13 323 CURVD FIGS	-0.01	-0.02	-0.02	0.01	-0.03
14 328 CMPREHEN:GROUP	0.34	0.34	0.37	0.36	0.34
15 329 CMPREHEN:INDIV		0.39	0.42	0.41	0.39
16 A201 MRT:SAT WORD			0.73	0.84	0.55
17 A205 MRT:SAT PGPH				0.73	0.54
18 M324 IQ:KUHL-ANDER					0.45

N = 504

Table A5.6
Reduced Correlation Matrix for End-of-Second-Grade Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 M305 VOCB:WISC SCA	0.50	0.59	0.42	0.39	0.43	0.49	0.39	0.45	0.47	0.32	0.39	0.32	0.31
2 M306 SIML:WISC SCA		0.44	0.30	0.37	0.41	0.47	0.39	0.47	0.47	0.32	0.41	0.27	0.38
3 M307 P.CM:WISC SCA			0.27	0.36	0.37	0.29	0.27	0.30	0.34	0.26	0.26	0.26	0.22
4 M308 BLKD:WISC SCA				0.39	0.53	0.43	0.40	0.42	0.46	0.31	0.38	0.29	0.36
5 M324 IQ:KUHL-ANDER					0.58	0.59	0.54	0.58	0.54	0.41	0.54	0.34	0.52
6 501 VOCABULARY						0.64	0.57	0.70	0.61	0.42	0.59	0.35	0.56
7 502 COMPREHENSION							0.48	0.56	0.53	0.39	0.53	0.28	0.49
8 503 NUMBER CMPARSN								0.60	0.58	0.42	0.55	0.34	0.53
9 504 PLACE VALUE									0.57	0.44	0.55	0.36	0.48
10 505 NUMBER LINE										0.31	0.38	0.27	0.38
11 506 APPLICATION											0.53	0.37	0.52
12 507 RATIONALS												0.22	0.29
13 508 ORDR:PICSET:GR													0.44

	14	15	16	17
1 M305 VOCB:WISC SCA	0.06	0.31	0.29	0.33
2 M306 SIML:WISC SCA	0.05	0.34	0.38	0.39
3 M307 P.CM:WISC SCA	0.05	0.28	0.22	0.27
4 M308 BLKD:WISC SCA	0.10	0.41	0.39	0.47
5 M324 IQ:KUHL-ANDER	0.17	0.54	0.55	0.52
6 501 VOCABULARY	0.20	0.52	0.54	0.46
7 502 COMPREHENSION	0.17	0.52	0.52	0.46
8 503 NUMBER CMPARSN	0.16	0.56	0.52	0.48
9 504 PLACE VALUE	0.10	0.55	0.54	0.58
10 505 NUMBER LINE	0.15	0.35	0.36	0.33
11 506 APPLICATION	0.17	0.56	0.57	0.49
12 507 RATIONALS	0.09	0.30	0.33	0.34
13 508 ORDR:PICSET:GR	0.14	0.48	0.52	0.43
14 509 COUNTING:GROUP	0.08	0.17	0.17	0.14
15 510 COMPUTE:ADD		0.60	0.70	0.54
16 511 COMPUTE:SUB			0.61	0.55
17 512 COMPUTE:MULT				0.49

N = 760

(CONTINUED)

Table A5.6
(second page)

		18	19	20	21	22	23	24
1	M305 VOCB:WISC SCA	0.13	0.00	0.15	0.04	0.09	0.45	0.45
2	M306 SIML:WISC SCA	0.12	0.03	0.18	0.07	0.05	0.41	0.42
3	M307 P.CM:WISC SCA	0.11	-0.02	0.18	0.01	0.06	0.26	0.24
4	M308 BLKD:WISC SCA	0.02	0.07	0.14	0.05	0.09	0.38	0.42
5	M324 IQ:KUHL-ANDER	0.11	0.01	0.19	0.01	0.10	0.56	0.62
6	501 VOCABULARY	0.15	0.01	0.19	0.05	0.09	0.54	0.57
7	502 COMPREHENSION	0.14	-0.01	0.18	0.03	0.07	0.51	0.55
8	503 NUMBER CMPARSN	0.18	0.03	0.16	0.05	0.04	0.51	0.57
9	504 PLACE VALUE	0.19	0.02	0.20	0.01	0.09	0.55	0.56
10	505 NUMBER LINE	0.20	-0.05	0.21	0.06	0.11	0.31	0.36
11	506 APPLICATION	0.18	0.02	0.16	0.06	0.02	0.45	0.50
12	507 RATIONALS	0.06	0.02	0.09	0.03	0.02	0.29	0.31
13	508 ORDR:PICSET:GR	0.13	0.01	0.12	0.02	0.07	0.39	0.45
14	509 COUNTING:GROUP	-0.01	0.03	-0.02	0.02	0.00	0.15	0.19
15	510 COMPUTE:ADD	0.05	0.06	0.11	0.01	0.05	0.47	0.56
16	511 COMPUTE:SUB	0.08	0.05	0.10	0.02	0.11	0.48	0.57
17	512 COMPUTE:MULT	0.08	0.07	0.14	0.01	0.15	0.49	0.53
18	521 IDFY PCLYGS	0.13	-0.18	0.17	0.07	0.02	0.15	0.15
19	522 CRVD&OPEN FIGS		0.06	-0.10	-0.01	0.03	-0.00	0.00
20	523 IDFY TRIANGS			0.12	0.11	-0.05	0.16	0.18
21	524 CONGRUENCE				0.13	-0.31	0.00	0.01
22	525 SIMILARITY					0.16	0.12	0.08
23	A301 #RT:SAT WORD						0.75	0.85
24	A303 #RT:SAT PGPH							0.79

Table A5.7
Reduced Correlation Matrix for End-of-Third-Grade Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 701 NO. COMP:ORDER	0.38	0.53	0.47	0.50	0.51	0.45	0.45	0.51	0.47	0.43	0.44	0.40	0.52
2 702 PLACE VALUE		0.53	0.42	0.54	0.49	0.48	0.53	0.63	0.61	0.61	0.56	0.57	0.62
3 703 NUMBER LINE			0.29	0.44	0.39	0.36	0.32	0.40	0.35	0.44	0.41	0.39	0.45
4 704 APPLICATION				0.60	0.46	0.54	0.55	0.60	0.55	0.66	0.56	0.57	0.57
5 705 RATIONALS					0.32	0.34	0.37	0.44	0.44	0.48	0.40	0.40	0.42
6 706 STRUCT OF SPAC						0.42	0.43	0.48	0.48	0.47	0.48	0.51	0.56
7 707 COMPUTE:ADD							0.57	0.67	0.60	0.70	0.49	0.52	0.57
8 708 COMPUTE:SUBT								0.64	0.61	0.71	0.56	0.59	0.63
9 709 COMPUTE:MULT									0.57	0.67	0.60	0.56	0.62
10 727 COMPUTATION										0.71	0.66	0.61	0.65
11 728 STRUCTURE											0.54	0.52	0.57
12 A401 ARI:SAT WORD												0.74	0.85
13 A403 ARI:SAT PGPH													0.78

N = 649

Table A5.8
Reduced Correlation Matrix for End-of-Third-Grade, WISC and Kuhlmann-Anderson Scales
Total Sample

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 701 NO. COMP:ORDER	0.38	0.49	0.39	0.49	0.30	0.44	0.44	0.49	0.46	0.47	0.43	0.45	0.50
2 702 PLACE VALUE		0.60	0.43	0.64	0.47	0.48	0.53	0.62	0.61	0.60	0.59	0.58	0.62
3 703 NUMBER LINE			0.32	0.45	0.32	0.37	0.33	0.41	0.36	0.45	0.42	0.41	0.47
4 704 APPLICATION				0.60	0.46	0.53	0.55	0.66	0.55	0.65	0.56	0.58	0.57
5 705 RATIONALS					0.33	0.37	0.36	0.43	0.43	0.47	0.45	0.40	0.42
6 706 STRUCT OF SPAC						0.41	0.42	0.47	0.48	0.45	0.46	0.52	0.55
7 707 COMPUTE:ADD							0.56	0.66	0.59	0.69	0.47	0.52	0.57
8 708 COMPUTE:SUBT								0.64	0.60	0.71	0.55	0.59	0.62
9 709 COMPUTE:MULT									0.58	0.67	0.59	0.58	0.63
10 727 COMPUTATION										0.71	0.65	0.61	0.65
11 728 STRUCTURE											0.54	0.53	0.57
12 A401 MRT:SAT WORD												0.74	0.85
13 A403 MRT:SAT PGPH													0.78

	14	15	16	17	18
1 701 NO. COMP:ORDER	0.37	0.37	0.28	0.34	0.41
2 702 PLACE VALUE	0.48	0.47	0.30	0.47	0.50
3 703 NUMBER LINE	0.32	0.31	0.29	0.35	0.41
4 704 APPLICATION	0.42	0.41	0.27	0.40	0.47
5 705 RATIONALS	0.32	0.34	0.22	0.36	0.40
6 706 STRUCT OF SPAC	0.37	0.34	0.24	0.38	0.41
7 707 COMPUTE:ADD	0.33	0.29	0.28	0.34	0.48
8 708 COMPUTE:SUBT	0.41	0.37	0.32	0.43	0.52
9 709 COMPUTE:MULT	0.32	0.33	0.28	0.39	0.45
10 727 COMPUTATION	0.36	0.38	0.28	0.43	0.54
11 728 STRUCTURE	0.36	0.35	0.32	0.45	0.48
12 A401 MRT:SAT WORD	0.49	0.46	0.27	0.38	0.53
13 A403 MRT:SAT PGPH	0.48	0.46	0.27	0.44	0.57
14 M305 VOCAB:WISC SC	0.48	0.59	0.41	0.38	0.39
15 M306 SIML:WISC SCA		0.42	0.29	0.37	0.37
16 M307 P.CM:WISC SCA			0.28	0.39	0.36
17 M308 BLKD:WISC SCA				0.37	0.47
18 M324 IQ:KUHL-ANDER					0.46

N = 614

ELMA REPORTS

No. 1. A Longitudinal Study of Mathematical Achievement in the Primary School Years: Description of Design, Sample, and Factor Analyses of Tests.

No. 2. A Longitudinal Study of Mathematical Achievement in the Primary School Years: Curriculum and Socio-Economic Comparisons and Predictions from Previous Achievement.

Single copies available from the school Mathematics Study Group, Cedar Hall, Stanford University, Stanford, Calif. 94305

ELMA TECHNICAL REPORTS

No. 1. Kindergarten Test Batteries, Description and Statistical Properties of Scales.

No. 2. Grade 1 Test Batteries, Description and Statistical Properties of Scales.

No. 3. Grade 2 Test Batteries, Description and Statistcial Properties of Scales.

No. 4. Grade 3 Test Batteries, Description and Statistical Properties of Scales.

Published by the School Mathematics Study Group, Stanford University, and available from A. C. Vroman, Inc., 2085 E. Foothill Blvd., Pasadena, Calif. 91109

University, and available from A. C. Vroman, Inc., 2085 E. Foothill Blvd., Pasadena, Calif. 91109